GENERAL PSYCHOLOGY

LEO F. MILLER, D.D.

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A History of Philosophy

BY THE

REV. LEO F. MILLER, D.D.,

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With an Introduction by the

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BY

LEO F. MILLER, D.D.

Formerly Professor of Philosophy in the Pontifical College Josephinum

Author of "A History of Philosophy"

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PREFACE

Since the experimental technique was devised for the study of psychic data, the expansion of psychology has been so extensive that it has been separated from its traditional place in the philosophical sciences, and in its turn divided into a number of highly specialized branches. But, before these new fields of psychology can be studied with the success that comes from the sure and accurate grasp of the fundamental psychological truths, a knowledge of General Psychology is indispensable. For, as the basic facts of any scientific structure determine the correctness of special hypotheses, principles, and methods, so the fundamental psychological facts are the necessary substructure of more specialized investigations into the nature and laws of psychic life.

The study of General Psychology also requires a series of metaphysical inferences as the ultimate interpretation of its empiric data. The experimental investigation of psychic data must be allotted its full share of time and attention, but the metaphysical study of the material acquired through several generations of infinitely patient research unfolds a crowning system of speculative truths that possess an eminently scientific character and have a deep and universal bearing on human life. To pass them over lightly would be dashing the flower from the cup and omitting the keystone from the arch. The

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principal theses of Rational Psychology are, therefore, an essential part of a treatise on psychic life.

Interest in psychology extends far beyond the ranks of psychologists, and not only into the curricula of schools, but also to the legions of cultured people classed as general readers. The psychic life experienced by all, from the first sensations that begin their waking hours to the last dim reflexions that fade away when the eyes close in sleep, has an interest and a fascination that grow with the passing years, as the average person wins or loses his rightful place in the toil and struggle of life. Numberless minds formulate the question whether the ceaseless flow of psychic happening in human consciousness is merely an act of cerebration, through which the universe mirrors itself in the brain, or whether there is a soul that thinks and wills in us.

The present treatise is an endeavor to answer again this age-old question also for the purposes of elementary classroom instruction, when one semester is devoted to General Psychology, and it is, therefore, limited to a brief exposition of essentials. Conciseness has everywhere been aimed at, both to give the student ample time for reflection and assimilation, and the instructor free scope in explanation. Technical terms are necessary in every science, and psychology is not an exception to this rule. But it is hoped that the Glossary at the end of the volume will smooth the student's way through the technical vocabulary of Chapters II and V. Only such terms have been entered in the Glossary as are not explained in the context. The derivation of many words has been added in order to make

them more easily understood and remembered. The transcription of Greek words into English characters may be questioned by philologists, but it is not without precedent and utility at the present day.

The readings listed at the end of each chapter contain more extended developments of the subjects treated than the limited space of the text allowed. Practical reasons necessitated a considerable abridgment of the original text, amounting at times to about one-half of the manuscript. Most of the suggested readings at the end of each chapter were selected from recent literature intended for students who are just beginning the study of psychology. The perils to which indiscriminate reading exposes the student whose judgment is not yet matured, are neither negligible, nor are they a matter of conjecture. Hence, the references for collateral reading are either limited to Catholic works in which such dangers are not present, or to other treatises in which they are, at least in the pages referred to, reduced to a minimum. In the latter instance, the entry of a reference into the reading lists, or into the short bibliography at the end of the volume, is not to be construed as a recommendation of the entire work, nor even of its fundamental principles, but only of what is not opposed to the Catholic Faith, nor to the principles of the philosophy which the Church prescribes for Catholic schools. Many an otherwise valuable book was omitted from the reading lists, because it propounds ideas against which we are warned by a source of truth that stands above the human mind. Several excellent Catholic works will also be found missing from the reading lists, because they are un-

fortunately out of print. The bibliographies at the end of the volume will initiate the student into more advanced and technical problems.

The usual sections dealing with neurology have been included in the text, not as though the teaching of this science were a function of psychology, but because the student beginning this study lacks this necessary knowledge.

The *Experiments* and *Problems* of Seashore and Snow, or those found in the other works referred to in the reading lists, will greatly further the student's comprehension of the subjects presented, and will stimulate his interest in them by making him apply and verify the theoretical exposition in the text.

It is a real pleasure to record my indebtedness and my sincere thanks to the Rev. Dr. Charles C. Miltner, C.S.C., Dean of the College of Arts and Letters in the University of Notre Dame, for a critical perusal of the manuscript and for valuable suggestions with regard to the text and the bibliographies.

Leo F. Miller.

Columbus, Ohio,
August, 1928.

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GENERAL PSYCHOLOGY

CHAPTER I

THE SCOPE OF PSYCHOLOGY

§ 1. THE OBJECT OF PSYCHOLOGY

1. Definition.—Psychology is the scientific study of the facts of consciousness and of the real principle on which they are intrinsically dependent. Psychology is a science, because it is a systematic and reasoned exposition of the facts, laws, and causes of our psychic activities. The facts or data of consciousness are all the processes of our soul of which we possess an immediate awareness, such as sensation, representation, feelings, and acts of thought and of will. Psychology studies them only as activities of the soul, describing, classifying, and explaining them in so far as they are processes of the soul, taking place within ourselves. Psychology leaves to other sciences the task of studying their objective validity, the objects they represent, and their moral aspects when they have such.

Psychology cannot restrict itself to the description and classification of the data of consciousness. It must also seek to determine by scientific proof the existence and nature of the soul, or principle from which our conscious activities proceed. The soul

is a real principle, because, though imperceptible in itself, it has actual existence and is not a fiction of the imagination. Our conscious activities are intrinsically dependent on it, because they can exist only in it, just as motion can exist only in the object moved.

The explanation of the data of consciousness sometimes goes beyond the factors of experience, because these data are not self-explanatory, and the principles of science derived from reality itself demand a sufficient reason for every phenomenon observed. The objective validity of this inference is not contingent upon the possibility of its experimental verification.

2. Historical Note.—Aristotle's (384–322 B.C.) treatise *On The Soul* is the earliest scientific work on psychology. He approached the subject by a study of the external characteristics of living beings (not from the inner characteristic of consciousness, as is usual in modern psychology), and therefore included man, animals, and plants within the field of psychology. He observed that the characteristic external difference between lifeless objects and living beings lies in the fact that the latter are composed of parts whose activities are in the service of the entire organism. Hence, he termed these parts "organs" (or instruments), and described living beings as organized substances. Though Aristotle distinguished psychology from natural science by its subject matter, he failed to distinguish it from biology, because he identified the principle of vegetable life with the soul. Aristotle defines the soul as "the first actuality of a natural body furnished with organs." "The soul is a substance," he says

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further, "in the sense that it is the entelechy of a natural body having in it the capacity of life."

Psychology has long ceased to be a department of biology, and plant life also is excluded from its field. The restriction of psychology to the data of consciousness takes its origin from Descartes (1596–1650), who classified objects into such as are extended and such as are conscious. He assigned to the field of natural science all objects to which the laws of mathematics can be applied, and to the sphere of psychology the objects to which these laws cannot be applied.

On the false assumption that all our knowledge is purely subjective, Kant (1724–1804) considered our inner experience as the object of psychology, and our external experience as the object of natural science. Wilhelm Wundt (1832–1920), the founder of the first psychophysical laboratory, regarded the psychical and the physical as two aspects of the same reality, the former being the object of psychology and the latter of natural science.

In order to determine correctly what is the object of psychology, it is necessary to bear in mind the existence of the external world, which is independent of our perception. All our psychic activities are ultimately caused by the action of external objects on our senses. Hence, these activities have a two-fold aspect. On the one hand, they proceed from the soul, and, on the other, their content is derived from the objects that cause the soul to posit them. In so far as they are activities of the soul, regardless of their content, they constitute the object of psychology. Their content and its relation to the objects that cause it, constitute an entirely different

field of investigation, belonging to other sciences. Hence, the object of psychology is distinct from that of other sciences.

§ 2. THE BRANCHES OF PSYCHOLOGY

3. Branches of Psychology.—The psychic life of man is so rich and varied that the study of its principal aspects has been organized into several distinct psychological sciences. The most important of them have been grouped together under the head of General Psychology, which studies the normal and fully developed psychic life of man. General Psychology includes: (1) Empiric Psychology, which studies the data of consciousness, their laws, and the correlations of body and soul, by means of the experimental method; (2) Rational Psychology, which studies the causes and principles of psychic activity on the basis of the experimentally established facts, by means of the deductive method. Among the other branches of psychology are: Differential, Individual, Racial, Social, Genetic, Dynamic, Comparative, and Pathological Psychology.

§ 3. THE METHODS OF PSYCHOLOGICAL RESEARCH

4. Methods of Research.—The scientific observation of the data of consciousness is the first stage of psychological research. Since these data are immediately perceptible only by the person experiencing them, introspection is the primary source from which they are obtained. But, as many of them are given external expression, the scientific study of all acts through which they become externally perceptible supplies much valuable material for psychologi-

cal study. Hence, the observation of others is a second important source of psychological material.

In order to furnish useful material for psychology, observation must be accurate, methodical, and correctly recorded. The accurate observation of one's own psychic activities is made difficult by the necessity of isolating them from their manifold associations with one another, their involuntary alteration through the concentration of the mind upon them, their brief duration, and our ordinarily vague perception of many of them. These sources of error must be eliminated by centering the attention on the activity under observation, and by causing it repeatedly under conditions favoring accurate observation. This is the psychological experiment.

Apart from accurate observation, the validity of such experiments depends principally on the definiteness of the problem proposed for study, the accurate control of all factors (both psychic and others) that enter into the experiment, and the suitability of the method employed, both as regards the material to be studied and the problem to be solved. Hypotheses are indispensable, but preconceptions are sure to vitiate the result.

The value of psychological experiments is greatly increased when they are conducted by a third person, because this method eliminates autosuggestion, prevents involuntary alteration of the psychic act under observation, makes the repetition of the experiment possible with different subjects under identical conditions, and increases the accuracy of the results by means of supplementary instructions given to the subject.

The direction of experiments by a third person also

makes possible a series of valuable psychological measurements (psychometry). In this way the reaction period,[1] the threshold of discrimination,[2] the psychic effects of attention, the influence of one psychic process on another, etc., are determined. The classification of stars into ten groups according to their degree of luminosity is a practical application of psychic measurements. But even in the many cases in which the nature of the psychic activities studied renders accurate measurements impossible, the mere establishment of other facts is a valuable achievement. In this way many phenomena of hypnotism have been profitably studied.

Collateral Reading.—MAHER, *Psychology*, pp. 1–24 (Definition, Scope, and Method of Psychology); MERCIER, *Origins of Contemporary Psychology*, pp. 69–215 (Masters and Characteristics of Contemporary Psychology); MOORE, *Dynamic Psychology*, pp. 3–12 (The Concept of Psychology); PYNE, *The Mind*, pp. 23–30 (Phenomenal and Rational Psychology).

[1] The reaction period is the time required for a response to a stimulus of sensation.

[2] The threshold of discrimination is the point where the difference between two stimuli begins to be appreciated.

CHAPTER II

THE PHYSIOLOGICAL BASIS OF PSYCHIC LIFE

5. Importance for Psychology.—The psychologist must be in possession of the principal facts regarding the bodily structures and functions that form the basis of conscious life, because the data of consciousness cannot be understood without the knowledge of them, the methods of psychological research cannot be otherwise determined, and the regulatory influence of the soul on the body cannot be otherwise understood.

Many of our bodily organs are directly in the service of conscious life, for all our knowledge begins with sensation, and the will directs many of our bodily movements. A knowledge of the fundamentals of the nervous system is necessary to the psychologist, because the soul acts on our sense and motor organs through the nerves. Hence, in order to build up a psychological treatise on the facts of experience, we must study, not only our conscious activities in themselves, but also those anatomical and physiological structures with which they are so intimately connected.

§ 1. THE CELL[1]

6. Physical Characteristics.—The principal physical characteristics that distinguish living beings from lifeless matter are:

(1) *structure:* every cell has a definite organization, and a multicellular organism is not a mere aggregation of cells. Its structural parts are united according to a definite arrangement. Their activities are subordinated to one another, but yet so coördinated as to promote the welfare of the organism;

(2) *chemical constitution:* organic compounds are highly complex;

(3) *origin:* every living being originates from another (biogenesis). There is no spontaneous generation;

(4) *the cycle of life:* every normal life passes through the stages of growth, conservation, and decay;

(5) *excitability:* all protoplasm has the property of being set into action and of reacting in a definite manner under the influence of external excitants.

7. The Animal Cell.—Leydig's definition of the cell as "a mass of protoplasm furnished with a nucleus," still holds good, except for some unicellular organisms, in which the chromidia take the place of the nucleus. The cell is the smallest part of an organism that possesses independent vital activity.

8. Structure of the Cell.—A cell consists of a jelly-like material (called *protoplasm*), which is surrounded by an envelope (called the *cell membrane*),

[1] See the Glossary at the end of the book for definitions of technical terms.

and contains a central body (termed the *nucleus*). The cell membrane is not necessarily a separate part. The protoplasm is composed of a more fluid part (called *paramitome*), and a mesh (or *mitome*) which permeates it. The nucleus contained in the protoplasm is separated from it by a distinct mem-

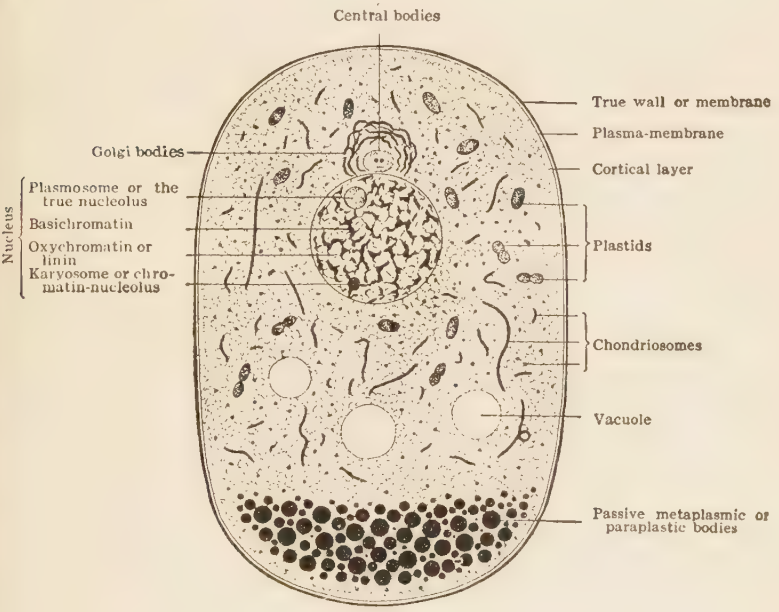

FIG. 1. DIAGRAM OF A CELL.

brane (called the *karyotheca*). Like the protoplasm, the nucleus also consists of a more fluid part (called *karyoplasm*) and the nuclear mesh (or *karyomitome*). The karyomitome consists of chromatin granules held together by linin. The most essential functions of the cell, such as metabolism, growth, and reproduction, are carried on chiefly by means of the nucleus.

Two further elements of the cell require mention. Most nuclei contain an intensely staining body, known as the *nucleolus*. It varies in size and shape, and is usually structureless. The number of nucleoli contained in a cell varies in number from one to five or more, not only in different kinds of cells, but also in different physiological conditions of the same cell. Many cells also contain a *centrosome,* which is a very small body, or more usually a pair of bodies, surrounded by the attraction sphere. The centrosome generally lies in the protoplasm, near an indentation of the nucleus, but sometimes it is found within the nucleus. When the centrosome is active, it is the center of a system of rays, and is supposed by some investigators to be the "dynamic center" governing the process of cell division.

Besides its constituent parts, a cell also contains the *metaplasm,* consisting of reserve products (which later serve for food) and waste products (which remain after nutrition).

9. Chemistry of the Cell.—Chemical analysis resolves the cell into:

(1) *water,* which comprises from two-thirds to three-fourths of its weight;

(2) *organic substances,* chiefly nucleo-proteins (that is, proteins combined with nuclein) and the organic non-proteids (lecithin and cholesterin). The lecithin of the cell may perform the functions of a more or less permeable membrane, confining the colloids and permitting the passage of the crystalloids of the protoplasm;

(3) *inorganic substances* (such as calcium, chlorine, potassium, and sodium), which enter into loose chemical combinations with the proteins. The cell

also contains oxygen, which is essential for metabolism, and, as an end-product of this process, carbon monoxide, which is never allowed to accumulate, but is constantly being expelled from the organism by respiration.

The chemistry of the nucleus is similar to that of the protoplasm in so far as both contain nucleic acid combined with protein.

10. Physiology of the Cell.—The protoplasm of a living cell is constantly undergoing chemical and physical changes, of which the principal ones are metabolism, reproduction, and excitation. (1) *Metabolism* designates the chemical changes which a cell undergoes. These changes comprise: (a) *anabolism,* or nutrition, which is the assimilation of food and its conversion into the complex and labile protoplasm constituting the substance of the organism; and (b) *catabolism,* which is the breaking down of protoplasm by the cleavage of the molecules into less complex and more stable substances. Some of these are excreted, but others are combined again with food, and thus serve to reconstitute the organic molecule and to restore the living tissue. (2) *Reproduction* is the division of a cell, by which new cells originate. (3) *Excitation* includes all reactions to physical, chemical, and electrical stimuli.

11. Cell Division.— New cells originate by the division of cells already existing. There are two kinds of cell division, *mitosis* and *amitosis.* Amitosis consists in the constriction of the cell, completely dividing first the nucleus and then the protoplasm. This form of cell division differs from mitosis, or indirect division, in the following essential respects: (1) the nucleus remains in the resting stage, and neither

the spirem nor the chromosomes are formed; (2) the amphiaster, which consists of two asters connected by the spindle, is not formed, and hence the centrosome plays no part in this form of cell division. The leucocytes of the blood, the giant cells of marrow, and a few other kinds of cells divide by amitosis.

FIG. 2. MITOSIS.

a, The reticulum, or resting stage, preceding mitosis. The karyomitome has the appearance of a net-work. *b*, The spirem. As the cell prepares for division, the net-work assumes the appearance of a skein of thread. *c*, The loose skein. The chromosomes begin to separate, and the nuclear membrane gradually disappears. *d*, Lateral view of the aster. *e*, The aster seen from above. *f*, Divergence of the chromosomes and constriction of the cell body. *g*, Two daughter-cells have been formed, and the division of the cell is completed.

Most cells divide by mitosis, in which the amphiaster is formed, the chromatin is converted into a thread, the thread is broken up into filaments termed chromosomes, and the latter are in their turn longitudinally divided into two halves. Thus each daughter nucleus receives perfectly equivalent portions

of the mother nucleus, while the proportion of protoplasm received is not necessarily equal.

§ 2. THE STRUCTURE OF THE NERVOUS SYSTEM

12. Consciousness and the Nerves.—There is a twofold relation between the body and the conscious life of man. In sensation a conscious process follows upon an organic function; and in motion, organic functions are released by a preceding process of consciousness. Neither the sense-organs nor the muscles are in immediate connection with consciousness, but they are connected with it through the central nervous system.

13. The Nervous System.—The nerves are thread-like structures, consisting of very slender filaments, by which sensations and stimulative impulses are transmitted to and from the brain and other organs. The nervous system consists of the nerves, their centers, and their end-organs, considered as a unit. It is made up of two parts: the central, or cerebrospinal system, and the sympathetic system. *The central nervous system* consists of the brain and the spinal cord, the nerves which pass to and from them, and the ganglia at the roots of some of these nerves. *The sympathetic system,* which is in the service of the vegetal functions of the organism, consists of the sympathetic nerves in front of the vertebral column, their ganglia, the branches they send to the viscera, and the plexuses they form.

The cerebrospinal and the sympathetic nerves do not constitute two independent systems, because the nerve fibers of the latter are derived from cells in the spinal cord and in the lower parts of the brain.

FIG. 3. THE NERVOUS SYSTEM.

In the head, Nos. I–XII, the cranial nerves. On the left side of the figure, I, cervical ganglia: 1–3. II, dorsal (thoracic) ganglia: 1–12. III, lumbar ganglia: 1–5. IV, sacral ganglia: 1–5. V, coccygeal ganglia. VI, plexuses: *a*, pharyngeal; *b*, cardiac; *c*, abdominal and pelvic.

But the structure of the nerves of the sympathetic system differs from that of the cerebrospinal system. Their fibers are much finer, they usually lack the medullary sheath, and their ganglia are situated, not on the nerve-roots (like those of the spine), but nearer the periphery.

The *tissues of the nervous system* comprise four elements: (1) *nerve cells,* which occur only in the grey matter of the brain and the spinal cord, and in the small groups known as ganglia, which are found on some peripheral and many sympathetic nerves; (2) *nerve fibers,*

which are the processes of nerve cells: they form the bulk of the white matter of the brain and the spinal cord (outside of which they are sheathed in connective tissues to protect them and to bind them together), and terminate either by a simple division of the fibers into a dendron or by their differentiation into special end-organs; (3) *neuroglia cells* and *fibers,* which are the sustaining tissue of the central nervous system: neuroglia cells are irregular star-shaped cells with processes in the form of fibers extending in all directions from the

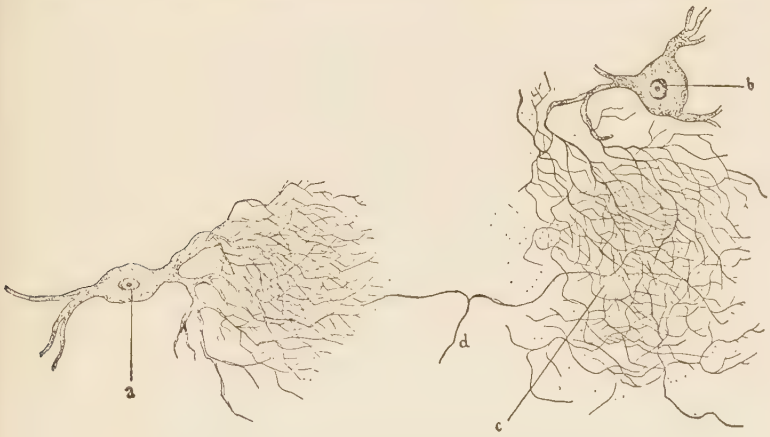

FIG. 4. TWO NERVE CELLS AND THEIR PROCESSES.
a, b, cells; *c,* net-work of nerve fibers interspersed with granules; *d,* branching nerve fiber, communicating with both net-works.

cell body; (4) the *ependyma,* which is the epithelial lining of the central cavities of the brain and the spinal cord. The nerve cells and their processes, therefore, are the essential parts of the nervous system.

14. Nerve Cells.—Nerve cells occur only in the grey matter of the nerve centers and in the ganglia

that are isolated extensions of them. The white matter of the nerve centers consists of medullated nerve fibers, which are processes of nerve cells enveloped by a myelin sheath. Every nerve cell has at least one fiber, and every fiber is an extension of a nerve cell. Nerve cells vary greatly in size, shape, and structure, but *their constant characteristics are the axon and neurofibrils,* the latter being continuous through the cell body and its processes. Nerve cells have a large and conspicuous nucleus, which is usually spherical and clear, and contains one or more nucleoli and centrosomes. The nucleus generally lies in the middle of the cell body.

15. Cell Processes.—Every nerve cell has at least one fiber, continuous with its own substance, issuing from it. These fibers are called *processes,* and the cell together with its processes is called a *neuron.* The point where the process issues from the cell body is termed the *pole.* Nerve cells are unipolar, bipolar, or multipolar, according to the number of their processes. In man some of the cerebrospinal ganglia are unipolar, but the sympathetic ganglia are always multipolar. The nerve-fiber processes vary in length from less than a millimeter (as in the grey matter in the cortex of the brain) to more than a meter (as in the fibers of the limb nerves).

The processes of nerve cells are either *axons* or *dendrons.* The *axon* is the process that constitutes the essential central nerve substance. The axon transmits the excitation of the nerve. Besides the axon, most nerve cells also possess short processes, which branch like the roots or branches of a tree immediately after leaving the cell body, and are therefore called *dendrons.* The axon differs from

the dendrons: (1) in its clearer appearance, because of the absence of the Nissl bodies; (2) in its smaller and more uniform size, whereas the dendrons become finer as they proceed farther from the cell; (3) in its branching into fine collaterals, whereas the dendrons arborize near the cell.

16. Neuroglia.—*Neuroglia* is the connective tissue of the nervous system. It consists of cells and of fibers that are continuous with them. It occupies the interstices between the neurons, thus separating and sustaining them. The numerous offset fibers of the neuroglia cells also support the neighboring nerve cells by passing through them and their processes. There are *three types* of neuroglia cells: (1) *spider cells,* which have many fine unbranched fibrils extending in every direction from the cell body; (2) *arborescent cells,* possessing many short-branched offsets, and found chiefly in the grey matter; (3) *vertical cells,* having three or four processes set with minute spines going vertically to the pia mater and attached to it.[1]

Nerve cells are connected by the branching of the axon around the bodies of other cells or their dendrons, or by the terminal dendrite of the axon interlacing with the dendrons of other cells, or by the interlacing of the dendrons of two or more cells.

[1] Nerve cells are probably not connected directly with one another, for there is strong evidence that every cell, together with its processes, forms a distinct anatomical unit. This is Waldeyer's "*neuron-theory.*" The evidence for it is contained in the following observations: (1) when neurons are stained by the Golgi method, their processes are intensely stained, but always appear to end in free branchings, and are never continued into the process from another cell, although they may come into contact with it; (2) certain diseases cause the degeneration of some nerve-cells, but not that of the others with which they are in close anatomical and physiological connection; (3) the only known mode in which nerve fibers grow, is as outgrowths from neuroblasts.

In some of the lower animals, the neurofibrils, which are characteristic of all nerve cells, appear to extend through two or more cells and their processes, but this does not prove their continuity. It is an established fact that there is at least no trophic continuity between neurons.

17. The Central Nervous System.—The nerve cells of the central nervous system form three great colonies: (1) *the peripheral colony,* which consists of the head ganglia of the sense organs, the nerve cells of the skin, and the spinal ganglia. The processes of this colony of cells go to the second colony; (2) *the subcortical nerve centers,* comprising the spinal cord, the corpora quadrigemina, and the optic thalami; (3) *the brain,* consisting of the cerebrum and the cerebellum. Each of these three colonies has its own *structural principle,* the first being isolated and attached to special organs, the second being a long cord in contact with all organs and following in general the configuration of the organism, and the third possessing the greatest possible expansion of surface.

The spinal cord is a cylindrical structure situated within the spinal canal, and composed of white nerve fibers externally, and grey ganglia internally. Like the brain, it is enclosed by *three membranes.* The *dura mater,* a strong fibrous membrane, is the outermost. Within this is the delicate *arachnoid.* The surface of the cord is closely invested by the *pia mater,* a highly vascular membrane. The spaces between the membranes are filled with the clear, cerebrospinal fluid. The cord is suspended and kept in position in the pia mater by ligaments occurring at frequent intervals and by the roots of the spinal

nerves, which go from the cord to the intervertebral openings. From the cord there issue at intervals *31 pairs of spinal nerves*—namely, 8 cervical, 12 dorsal, 5 lumbar, 6 sacral—and *12 pairs of cranial nerves*. Each nerve is attached to the surface of the cord by two roots, the forward one being non-gangliated and the rear one provided with a ganglion. The spinal cord is incompletely divided into two halves by a forward and a rear fissure, the former especially containing many blood-vessels.

FIG. 5. THE UNDER-SURFACE OF THE BRAIN.

a, *b*, right and left frontal lobes; *c*, *d*, right and left temporal lobes; *e*, pons Varolii; *f*, *g*, cerebellum; *h*, commissure to cerebrum; *i*, commissure to cerebellum; *k*, medulla oblongata; *l*, spinal cord; *m*, corpora mamillaria; *n*, optic chiasm; *o*, olfactory nerve.

18. The Brain.—The brain is the enlarged and much modified part of the nervous system contained within the cranium. It consists of the cerebrum, the cerebellum, and several minor parts. The *cerebellum* lies below and behind the cerebrum, and consists of two lobes (or hemispheres) joined by a middle lobe, which is called from its transverse ridges and furrows the worm, or the vermiform process. The cerebellum is characterized by deep, close, transverse, and somewhat curved fissures. Its transverse diameter is about ten centimeters, its

greatest vertical diameter about five centimeters. It weighs about 142 grams. The cerebellum is composed outwardly of two layers of grey matter and inwardly of white matter. The two layers of grey matter are separated by the cells of Purkinje, a stratum of large nerve cells. The outer layer contains scattered nerve cells, many nerve fibers, and the dendrons of the cells of Purkinje. The inner layer contains many small reddish brown nerve cells, called granules.

The *cerebrum* is separated in the major part of its extent by a great longitudinal fissure into two hemispheres, which are united by commissures. The surface of the hemispheres consists of a layer of grey matter, two to three millimeters thick, which form the cortex. In nearly the whole of its extent the cortex is formed into numerous folds separated into fissures. Beneath the cortex is a large mass of white matter composed of nerve fibers, which connect the different parts of the brain with each other or with the spinal cord. In addition to the cortex, the brain contains various other masses of grey matter situated more deeply, such as the corpora striata and the thalami, which are known collectively as the basal ganglia of the cerebrum.

The great majority of the lobes and fissures of the cerebrum are typical, being approximately identical in all individuals. Hence, special names have been given to them for quick and easy identification. A knowledge of the principal areas of the brain thus determined is necessary for the study of the localization of organic functions in the brain.

The lobes and fissures of the brain enable it to harbor a very large number of cells on its surface,

thus obviating the difficulties which would result from multicombinations of superposed layers of these cells. The purpose of the arrangement of the brain cells on a large thin surface is the connection of all parts of the nervous system with each other. All the organs of the body are closely linked together in this way, and the whole organism is completely unified by means of the brain.

The outstanding characteristic of the outer layers of the brain cells is their wealth of combinations. The projection fibers connect the brain cells with the subcortical nerve centers; the commissural fibers join the hemispheres of the brain; and the association fibers connect the cells of the same hemisphere. The association fibers are the most numerous and important. They are grouped in three areas: the rear half of the hemisphere, the part just behind the forehead, and the forward end of the fissure of Sylvius. In animals the association fibers are little developed.

§ 3. THE FUNCTIONS OF THE NERVOUS SYSTEM

19. In General.—The cell is the seat of nervous activity. The function of the nerve processes is to conduct the excitation of the nerves and of their end-organs to other nerve cells and to the bodily organs. Vital activity is *accompanied* by important chemical and electromagnetic changes in the nerve substance, but it *is not* this change.

20. Conduction.—Conduction is the transference of the influence of a stimulus along the nerve fibers from the point of stimulation to the nerve center. Anatomical continuity and integrity of the nerve are

the fundamental conditions for conduction. The continuity of the nerve is destroyed by dividing it. Physical contact of the divided parts is not sufficient for conduction. Compression of the nerve also prevents conduction. In this way the conduction of a frog's sciatic can be inhibited by a weight of only a few grams; but, after the pressure is removed, conduction returns within a few seconds.

The excitement of one nerve does not pass over to other nerves during its course along the nerve process. This is the *law of isolated conduction.* The excitement is communicated to other nerves only at the end of the process or of its collaterals. Experiment on exsected nerves shows that conduction is physiologically possible in both directions along the nerve. But the normal direction of conduction in the organism is centripetal in sensory nerves (going from the peripheral cells to the cortex of the brain) and centrifugal in the motor nerves (going from the nerve center to the muscles).

Whether a nerve is excited at its end or at a point along its course, the effect on the organ of reaction is always the same—muscular movement for motor nerves and sensation for sensory nerves. This is the *law of the constant effect of nervous conduction.* Similarly, the location and nature of the sensation produced by stimulating any part of a sensory nerve of the skin is always the same as that produced by the natural stimulus of the end-organ in the skin. This is the reason why the cutaneous nerves of the stump of an amputated limb possess the same sensations of which the lost member was capable.

Helmholz states the rate of conduction of the motor muscles of man as 30 to 35 meters per second.

Piper in 1912 gave the rate as 123 meters per second, according to measurements obtained by means of a string galvanometer. The rate of conduction is independent of the strength of the stimulus, but not of the temperature of the organ.

21. Stimulation.—Stimulation is the application of an excitant to a nerve. Although stimulation is physiologically possible at any point of the nerves, their end-organs are the only natural place for the stimulation of the sensory nerves, and the central organ of their origin for that of the motor nerves. The fact that every nerve is naturally excitable only at one end, and only by a definite kind of stimulus, is an admirable teleological arrangement, preventing the chaotic disorder that would result in the organism if the nerves could be excited at every point of their course and by every stimulus. The internal stimulus of a nerve originates in a sense organ or in the brain.

External stimuli are divided into four classes: (1) *mechanical,* such as pressure applied to cutaneous nerves, causing a sensation of pain and a twitching of the muscles; (2) *molecular,* such as the application of heat. The natural temperature of an animal does not stimulate its nerves, but regulates their excitability; (3) *chemical,* such as gases exciting the senses of taste and smell; (4) *electrical current.* This is the best experimental excitant of a nerve and has the strongest analogies to physiological stimuli.

The effectiveness of an external stimulus depends on its intensity, its suddenness, its manner of acting on the nerves, and on the excitability of the nerve. Thus, if a stimulus is too weak, it produces no effect; if it is too great, it paralyzes or even destroys the

nerve. A constant electric current may not be felt, but it is felt if it is suddenly applied or varied. A flickering light stimulates more than a steady light of the same intensity. As to its manner of acting on the nerve, an electric stimulus produces its maximum effect at the moment it is applied to motor nerves and at the moment it ceases.

Excitation, the effect of stimulation, is a psychic process, and therefore cannot be described in terms of its accompanying physical, chemical, and electric phenomena. But these phenomena, together with the various psychic activities of the organism, form the data for the investigation of the nature of the excitement of the nerves.

22. Relation between Stimulation and Excitement. —(1) As long as the stimulus remains within the stimulus-scope (that is, within the difference between the stimulus-threshold and the measure of receptivity), the intensity of the excitement of the nerve varies with that of stimulation. (2) Stimulation of the nerve process produces greater excitement than the same stimulation of the cell. (3) Stimulation must have a certain intensity to produce a conscious effect. If it lacks this degree of intensity, it does not cross the threshold (that is, the least amount of stimulus required to produce a conscious effect). But a very rapid succession of stimuli that are separately imperceptible, effects a conscious excitement of the nerve, because the preceding members of this series continue their unconscious effect in the organ for a short time, and thus enable the succeeding ones to build up on them and so to cross the threshold. This phenomenon is called the *summation of*

stimuli. (4) An extended succession of very intense stimulations diminishes the excitement of the nerve by fatiguing it. (5) Certain pathological conditions increase the excitability of the nerves. Thus, poorly nourished, degenerating, and atrophying nerves are more excitable than those in a normal condition, as the observation of neurotics and delirious persons shows.

23. Fatigue.—Fatigue is the gradual decrease in the excitability of the nerve. It consists: (1) in the production of toxins in the muscles. This is fatigue in the proper sense; (2) in the consumption of energy-producing substance in excess of restoration. This is exhaustion rather than fatigue. The toxins are removed by the circulation of the blood; the nerve substance is restored during rest by nutrition. The seat of fatigue is rather in the muscles, glands, and sense organs than in the nerves; for, when a motor nerve is excited, the muscle becomes fatigued long before the nerve. The nerves are not easily affected by fatiguing influences; but, once fatigued, they are restored with great difficulty.

§ 4. REFLEXES

24. Reflexes.—A *reflex* is the involuntary transformation of a centripetal into a centrifugal nerve impulse by means of a central organ. In reflex acts the peripheral endings of the ganglia of the spine and the head are excited by an external stimulus. The excitement thus conducted to the subcortical nerve centers is there transferred to the centrifugal fibers of other neurons and so conducted as a motor innervation to muscles, blood-vessels, and glands.

Among the most common reflexes are the adjustment of the pupil of the eye to the light, winking the eyes when threatened, recovering one's balance when slipping, sneezing when the mucous membrane of the nose is stimulated, coughing from stimulation of the glottis, blushing, and blanching.

The proof that the brain has no part in these reflexes lies in these facts: (1) the reflexes are more rapid than the involuntary acts in which the brain is known to have a part, and some of them cannot be made conscious; (2) they are found in new-born children, whose brain has hardly begun to function; (3) in favorable conditions, they have been performed by animals whose brain had been removed.

25. Characteristics.—Reflexes are characterized by regularity and uniformity. The same stimulation always brings the same motor reflex from the subcortical centers. These reflexes are found already in the youngest infants, an observation which shows that they are unacquired. Thus, the infant swallows food, regularly closes its hand when the inner surface is stroked, and opens its hand when the outer surface is stroked.

The nature of the reflex is determined by the quality, intensity, and place of stimulation, and by the state of the nerve centers participating in the reflex. Thus, the tail of an eel moves toward a tactile stimulus, but it moves away from a painful stimulus. A weak stimulus brings about a reflex in only a few motor fibers, but a strong stimulus spreads the reflex to many motor fibers. Reflexes brought about by stimulating the viscera differ from those caused by stimulating the skin. Finally, the reflex excitability and conductivity of the spinal

cord are lowered by toxins and completely inhibited by anesthetics; on the other hand, they are increased by strychnine.

Reflexes possess the further characteristics of inhibition and facilitation. Inhibition is the weakening or the suppression of a reflex, caused by the simultaneous presence of a sense stimulus other than that causing the reflex. Thus, if a frog whose brain has been removed is gently stroked on the back between the shoulder-blades, it begins to croak; but, if its hind leg is pinched at the same time, it remains silent. This experiment shows that one stimulus can be impeded by another that engages the same nerve centers at the same time.

Facilitation is the intensification of a reflex by a different stimulation of the same group of cells. For example, the contraction of a frog's leg produced by simultaneous cutaneous and optical stimulation is considerably greater than the sum of the contractions produced by the separate application of these stimuli.

26. Classification of Reflexes.—Reflexes may be divided into two classes. (1) In abnormal injurious stimuli, the reflexes are in proportion to the strength and duration of the stimulus. If the stimulus is weak or brief, the reflex aims to remove the body from the stimulus. But, if the stimulus is strong or protracted, the reflex aims to remove the stimulus from the body. (2) Normal stimuli are beneficial to the organism, and the reflexes they cause are in relation to the nature of the stimulus, not to its strength or duration. These reflexes are produced only by the application of the natural stimuli to the peripheral organs that normally receive them. As

a rule, they do not spread to different muscles, like those caused by abnormal injurious stimuli.

27. Value.—Reflex actions are very important for the welfare of the organism. (1) They are teleologically coördinated to bring about psychological and purposive activities, such as breathing, swallowing, walking, grasping, bending, etc. Every one of these simple acts implies a vast amount of muscular and nervous coördination, because it requires the use of several muscles, each consisting of thousands of fibers, which must be separately innervated. For each muscle, hundreds and even thousands of cells must be excited in the same degree. The various muscles that perform the reflex coöperate in different ways and degrees in the reflex act, and therefore require different innervations. This extensive and delicately coördinated activity is often effected by only a slight stimulation of a few sensory fibers; and yet the whole action is quickly, correctly, and spontaneously performed.

(2) The reflexes correspond to the value of the different kinds of stimuli for the organism; useful stimuli attract, while harmful ones repel. Thus, when food is given to an infant, the mouth opens, contracts, draws the food inward, and, if necessary, the head reaches forward to obtain the food. But, if a bitter object is approached to the infant's mouth, the mouth is distended, the tongue pushes the object away, and the head turns aside. Similarly, when a pleasant light is brought near the infant, it turns its head toward the light and focuses its eyes upon it. But, if the light is very intense or flickering, the infant closes its eyes and turns away its head.

The formation of association centers enables the

organism to carry out complicated reflexes. The ganglion cells of the muscles that are physiologically connected and possess identical functions, are so associated by means of cells and collaterals that the excitement of one muscle is at once communicated to all the muscles of the group. When the muscles are to function in different ways in the same reflex, different groups of ganglia are subordinated to each other.

28. Limitations.—Reflexes have the defects of their qualities. They all are directed to the welfare of the organism, but they are not alone sufficient to protect it from harm, they are not perfected by practice, and they often entail a prodigal waste of effort. Here the influence of the mind, acting through the brain on the subcortical nerve centers and on the reflexes that proceed from them, acts as a corrective, facilitating useful and inhibiting harmful effects on the organism, which result from indiscriminately functioning reflexes, by modifying the reflexes according to the dictates of reason and experience.

§ 5. ASSOCIATION PATHS AND LOCALIZATION OF FUNCTIONS

29. Association Paths.—While the subcortical nerve centers are essentially complete and fully formed organs at birth and not greatly developed by use, the brain continues to develop for many years through the exercise of its functions. By this means a large number of connections between association fibers are produced, many conduction paths are enlarged and strengthened by use, while the more circuitous paths are left unused and undeveloped. It

is probable also that the centers most used approach one another. Through the development of these association paths, inertia is partly overcome, related function centers are activated through stimulation reaching only one of them, and harmful scattering of nerve excitement is prevented.

30. The Law of Association.—The following law of association has been formulated to explain complicated reflexes: when two fields of the central organ are functioning at the same time, a conduction path is formed between them, if it does not yet exist; but, if it is already present, it is perfected in such a way that in future the conduction of the excitement takes place along it more easily, quickly, and with a smaller loss of energy than along any other path not possessing this experience and practice. The excitement of the association path, which is thus formed or perfected, and of the two function fields leaves a permanent disposition in each of these fields, in virtue of which a lesser stimulation will in future excite it to perform the same function again, and will also excite the second field to perform the now associated function.

31. Specific Sense Energy.—The law of specific sense energy declares that the stimulation of a sensory nerve produces in it only that form of excitement, and consequently only that kind of sensation, which is proper to it. Thus, all stimuli to which the optic nerve is capable of reacting, whether they be mechanical, chemical, optical, or electrical, produce only visual sensations in it. Similarly, the auditory nerve reacts only by auditory sensations to all stimuli capable of exciting it, whether they be mechanical, chemical, or electrical. The same is true

of the other senses. The proof of this law consists in the facts mentioned. It assumes only the reality and specific difference between the sensations proper to the different senses.

Attempts have been made to show that the various qualities of each kind of sensation excite different parts of the sensory nerve endings. Thus, every sound is said to excite a different fiber of the auditory nerve. This extension of the law of specific sense energy is inapplicable to the senses of taste and smell. It is problematical with regard to the optic nerve and partly verified for cutaneous sensations.

The nature of the specific sense energy has not been ascertained, nor have the nerve elements been determined in which it resides. The view of Johannes Müller (who first formulated the law) according to which it consists in a peculiar power or "energy" inherent in each sense, is untenable. Nor has the view of Helmholz, according to which this "energy" resides in those ganglion cells of the brain in which the sense functions are localized—or that of other investigators according to whom it resides in the end-organs—been proved. The last-mentioned view is the more probable, but it is worthy of remark that sensory nerves without special end-organs are also capable of only one specific response to stimuli.

32. Localization of Organic Functions in the Brain.—In studying the localization of functions in the brain, it is necessary to bear always in mind that the principle from which all sensory acts proceed is not the body alone, nor the soul alone, but the composite human substance, which is constituted

by the union of the body and the spiritual soul into one nature. Furthermore, purely spiritual acts, like thought and volition, cannot be localized in a bodily organ, for they are not material and the body is not their principle. However, any sensory form in which they are expressed, organic activities of all kinds which accompany them, and the physical element of the memory's record of them may all in principle be localized in the brain.

Cerebral localization is the determination of the place of the function centers in the brain. The anatomical foundation of the localization of organic functions in the brain is found in the relation of the cortex to the peripheral organs. These organs are structurally connected with definite areas of the brain. Hence, these areas have the same relation to the organic functions as the corresponding peripheral organs. Just as the sensory activities of the organism are divided among the different senses, so also a corresponding division of functions obtains in different areas of the brain. Thus, visual sensations are localized in the cortex of the occipital lobe, which is in close anatomical connection with the eye. Auditory sensations are localized in the cortex of the temporal lobe, which is connected with the ear. Organic and tactile sensations are localized in the parietal lobe; sensations of smell in the hippocampal region. The cortical impulse for bodily movements proceeds from the anterior parietal region of the cortex. Complex sensory actions imply the stimulation of several different areas: for example, the sight of an orange may stimulate the olfactory, the tactile, and the speech areas.

Electrical stimulation and the removal of various

areas of the brain are the two methods employed to localize the organic functions in the brain. The localization of these functions is not the same in all animals, nor is it always the same in man as in animals.

33. Vicarious Substitution.—The removal of the sensory or motor areas of the brain not only destroys the functions localized in them, but also inhibits others, of which the areas have not been disturbed. In animals the functions of the parts removed begin to return within several weeks after the operation. In this case we have vicarious substitution, which consists in one part of the brain taking over the functions formerly localized in another part.

Vicarious substitution occurs in two forms: (1) the extension of the function field, in which the nerve elements that hitherto performed only a part of a complex function, perform the entire function after the removal or disability of the other parts required for it; (2) acquisition of new functions, in which certain areas of the brain, after the disability or removal of the other parts required, acquire functions they did not formerly exercise.

Collateral Reading.—Watson, *Psychology from the Standpoint of the Behaviorist,* Chapter IV (Neuro-Physiological Basis of Action); Warren, *Human Psychology,* Chapters II–V (The Neuro-Terminal Mechanism; Physiology of the Neuron; Stimulation, Adjustment, and Response); Ladd and Woodworth, *Elements of Physiological Psychology,* Part I, Chapter VII (Reflex Functions of the Nervous System); Moore, *Dynamic Psychology,* Part II (Stimulus and Response and Human Behavior); Windle, *Vitalism and Scholasticism,* Chapters III–VIII (The Cell).

Snow, *Problems in Psychology,* Chapters II–III.

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CHAPTER III

CONSCIOUSNESS

§ 1. THE NATURE OF CONSCIOUSNESS

34. The Unconscious.—The idea of "the unconscious" was made current in modern philosophy by Eduard von Hartmann. By this term he designates the principle of all things, which is psychic in character, but by its very nature incapable of any conscious act. Hartmann's erroneous theory of panpsychism is not under discussion here, nor can the application of the idea of "the unconscious" to psychological phenomena be questioned when it designates that which is unintended, unnoticed, mechanically performed, or incapable of being recalled. But the assertion that there are essentially unknowable, and in this sense unconscious, psychic activities in man, is an erroneous assumption, which Hartmann and his followers postulated for systematic reasons without a demonstrable basis of fact. Many of the facts alleged in proof of essentially unconscious activities of the soul are explained on careful investigation as conscious processes of slight development, very short duration, and unnoticed occurrence. Unconscious causes of psychic activities could be admitted only if these and similar factors were in principle definitely incapable of explaining

them. Since the soul is a substantial principle, not a series of conscious acts, it has not only conscious activities, but also ontological properties, states, and acts which inhere in it. We are not conscious of the spirituality of the soul, nor of the actual process of abstracting ideas from sensory data, but this condition of things is far removed from Hartmann's theory of the unconscious.

35. Nature of Consciousness.—Consciousness is the immediate awareness of our psychic experience. Psychic and physical being are distinguished by the fact that the former is purely intentional in character, does not exist in space, and produces no effects in the external world. Our own psychic acts are immediate objects of consciousness, because they are in themselves present in the faculties perceiving them. Our awareness of them is a primitive act of unreflective cognition, which is the foundation of other cognitional acts by means of which the mind obtains a knowledge of the nature of our psychic acts and of the objects they represent to us. Among the acts of the mind by which the cognition constituting our initial consciousness of objects is developed into a full knowledge of them, are noticing, comparison, distinction, analysis, abstraction, and apperception. We begin to *notice* our inner experience when we direct our attention to it and *distinguish* its twofold aspect of being an act of the soul and a representation of an object. In this incipient stage of knowledge we distinguish our subjective experience of the psychic act from its objective content. Then we *compare* the content of the act with the content of other psychic acts, and find that each possesses its own identity. Continuing the compari-

son, we *analyze* the content of distinct psychic acts by separating them into their components, and by observing which of these components are common to more than one content, and which are proper to any of them. Finally, the act of *apperception* takes place when we interpret the content of a psychic act, class it, name it, and join it with other previously known contents by reason of its similarity or identity with them. This exposition of the mind's progressive cognitional activity, which can easily be verified by observing oneself, shows that the psychic acts we term consciousness are initial cognitional acts, but that they are distinct from knowledge as understood in the full sense.

The sensory content of consciousness possesses the important characteristic of being devoid of the corporeal properties it represents. The perception of a blue disk is not itself blue nor extended, nor does the soul acquire these properties by perceiving them. This is due to the fact that the existence of an objective content in consciousness consists in its being perceived.

§ 2. THE CONTENT OF CONSCIOUSNESS

36. Classification.—The content of consciousness consists of so many and such varied experiences that a detailed classification facilitates their comprehension. There is no generally accepted classification of the content of consciousness, but the following scheme will be found useful for purposes of study. The content of our consciousness is either: (1) fundamental or derived; (2) sensible or spiritual; (3) experienced or recalled; (4) objective or subjective.

The second group in this list is metaphysical; the others are empirical. The same content may belong to several of the above classes.

37. Fundamental and Derived Content.—A fundamental content is one that is first in its own order. A derived content is one that originates by the combination or elaboration of fundamental contents. The relation of fundamental to derived content is like that of element and derivative, not that of cause and effect. In the order of time the derived content may precede the fundamental content in consciousness, as in the case where the latter is determined by analysis. A harmony is a derived content of which the constituent tones are the fundamentals. Concepts are the fundamentals of the judgments composed of them. Joy and sorrow may often be derived from the fundamentals of pleasure and pain.

38. Sensible and Spiritual Content.—A sensible content is one that takes place in a sensory or a central organ. A spiritual content is one that is in the mind or the will. This distinction cannot be empirically observed, but it is inferred from the specifically different nature of the sensible and the spiritual content. The sensible content is concrete, and the spiritual content is abstract. The frequent vagueness of the sensible content does not spiritualize it, nor does the definiteness of a spiritual content materialize it. Blue, this house, and John Smith are sensible contents of consciousness. Blueness, being, virtue, and book are spiritual contents.

39. Experienced and Recalled Content.—An experienced content is one that is formed in our consciousness by the use of our own faculties. A recalled content is a past experienced content of our

own consciousness that memory brings back into it again. When we solve a problem in logic, suffer the pangs of hunger, or endure the horrors of war, these acts are experienced content while they are taking place. When we remember them in later years, they are recalled content. Every experienced content is capable of being recalled. Experienced and recalled contents are often mingled. When we see the Roman Forum for the first time, many facts of Roman history that we have previously read are apt to crowd upon our memory as recalled content. On the other hand, our memories of a journey long past are likely to be mingled with the desire, now first experienced, to visit places of interest that we formerly overlooked.

40. Objective and Subjective Content.—An objective content is one that represents a real or imaginary object without any further relation. A subjective content is one that expresses our psychic attitude toward an object of knowledge. Sensations, sense perceptions, representations, and concepts are objective contents. Feelings, acts of the will, and judgments, when the latter are psychologically considered, are subjective contents. It is to be carefully noted, however, that the acts of the intellect, considered in their logical and metaphysical aspect, are not subjective contents. The distinction between objective and subjective contents does not subjectivize logic and metaphysics. The mind's true or false judgment concerning an ontological truth is its attitude toward that truth. But the correctness, error, or even the morality of this attitude does not affect the existence and the validity of this ontological truth for the mind forming the judgment.

3. THE STRUCTURE OF CONSCIOUSNESS

41. Nature and Properties.—Consciousness is here understood as the aggregate of all the psychic experiences of an individual person. The structure of consciousness, then, is the connection of the psychic experiences of an individual into a unit and their relations to one another within this unit.

Many psychic experiences are commonly present in consciousness at the same time. We simultaneously see, touch, taste, and smell food. But these four experiences are so connected in our consciousness that we refer them all to the same object, and consider them as belonging exclusively to ourselves. During the course of the day, our psychic experiences are enlarged into an uninterrupted series of sensations, emotions, representations, thoughts, and volitions. The analysis of these facts reveals three important properties of the structure of consciousness, namely, *succession*, *unity*, and *continuity*.

When several psychic experiences take place at the same time, they are often in different degrees objects of our *perception*, and some of them may entirely escape observation. When walking with a companion, we may be so engrossed in conversation that we perceive the passers-by only vaguely, hardly notice the chilly temperature, and utterly fail to become aware of the peal of the chimes in the tower near-by. For purposes of study, the number of objects we perceive at one time is termed the field of consciousness. Within this field, those objects toward which we direct our attention are said to lie within *the focal point* of attention and to constitute *the focal idea*; while the others, which are attended

to in a lesser degree, are said to lie in *the fringes* of the field and to constitute its *marginal process.* Intensive attention directed to one object affects our awareness of other objects simultaneously perceived, by rendering it vague, weak, and furtive, and in many instances by preventing any conscious perception of them.

42. The Stream of Consciousness.—The stream of consciousness is the continual flow of psychic happening, the continuous succession of states and acts of consciousness. All psychic acts and processes of which we are conscious form the content of this stream. The successive character of our existence and action is the reason of the flow of our psychic experience.

The stream of consciousness is constituted by two factors: (1) the continually changing content of our consciousness, comprising sensations, perceptions, thoughts, etc., and (2) our perception of this content and of its continual change. We possess an immediate awareness, not only of the content of our consciousness, but also of its rapid succession in our psychic panorama. Our perception of the change of the content of consciousness is itself subject to constant change. For, when we attempt to review the psychic experiences of the day, we perceive them in successive sections of only a few seconds' duration. Yet this short interval, which is all that we are able to span of the stream of consciousness at one time, is long enough to enable us to perceive clearly the content and its change.

The successive character of our perception is the essential constituent of the stream of consciousness, for the stream would continue to flow even though

its content were devoid of succession. Even when a given content remains long in our consciousness, as may be the case with figures and concepts, our perception of it continues to flow steadily on, that is, it undergoes a process of change. Our perception is essentially successive, and this successiveness is the essence of the stream of consciousness.

43. Unity of the Stream of Consciousness.—The unity of the stream of consciousness is the organization of its constituent factors into a whole. The changing content of consciousness and our successive perception of it are not identical, because the latter endures slightly longer than the former. But neither are they two separate, and therefore merely co-existing factors. They form an organic unit, because: (1) the various experiences that form the content of consciousness are a unit among themselves in so far as they influence and condition one another in many ways. Thus, the vividness of one content may inhibit the development of a different one, and it may facilitate the development of a similar one; (2) perceptive acts permeate and therefore connect all parts of consciousness, and thus refer them to one subject; (3) one knowledge embraces the whole stream of consciousness; it is the psychic experiences of one person.

44. Continuity of the Stream of Consciousness.—The continuity of the stream of consciousness is its uninterrupted succession. There is a threefold continuity in the stream. (1) *Continuity of function.* Our consciousness is never "empty." As long as we are conscious, an unbroken stream of objects and perceptions flows on in the soul. (2) *Subordination of activities.* The higher activities of our conscious

life subordinate the lower ones to themselves and function at the same time with them. The sensations, representations, and concepts which a given object causes in us, are simultaneous, not successive. We do not normally acquire first the sensation of a tree, then the representation of its extension in three dimensions, and finally its abstract concept. These three activities of the soul take place at the same time. In the same way, sense appetition and volition are often simultaneous. (3) *Interaction of activities and their products.* The activities of our conscious life and their products exercise a reciprocal influence on one another. Concepts are not only abstracted from sensations or built up on other concepts and thus conditioned by them, but we are prone to interpret our sensations in the light of our concepts and of the memories of former experience. Imagination and expectation lead us to see apparent connections between ideas and sensations which do not exist.

§ 4. PSYCHIC DEVELOPMENT

45. The Development of Consciousness.—The development of the individual's consciousness is the gradual actuation of his psychic faculties. An infant cannot at once use all the faculties of his soul. The use of the higher faculties is prepared by that of the lower ones. This preparation continues until the child reaches the age of reason, when it can use its intellect and its will. The origin of the higher psychic activities of man is nativistic in so far as all his faculties are inborn, and it is empirical inasmuch as their exercise is conditioned by experience

and the normal development of his sensory organs. Even in the adult, the psychic faculties that are constantly used continue to develop until about his fiftieth year.

The principal stages of the psychic development of the individual are the psychophysical, the psychophysiological, and the purely psychic stage. The succession of these stages of development is characterized by the progressive independence of psychic life from matter and material conditions.

(1) The earliest and most rudimentary stage of psychic development is *psychophysical.* During this period all psychic activities are directly dependent on the action of sensory stimuli on the organs. Hence, the causes of these activities proceed from the external world and from the periphery of the body. The psychic activities of this stage are sensation, feeling, and impulse.

(2) In the *psychophysiological* stage, man is independent of external stimuli in his psychic activities, but he is still directly dependent on sense memory and imagination, and hence on the coöperation of the brain. Representation and sense appetition are the activities characteristic of this stage.

(3) In the *purely psychic* or spiritual stage of his conscious life, man possesses psychic activities that have no material components, and of which cerebral processes are not intrinsic constituents. Thought and volition are the activities characteristic of this stage. But even in this, the highest stage of psychic development, man is still indirectly and mediately dependent on physical and physiological processes, because his ideas are abstracted from sensations, and the latter proceed from sensory stimuli. But the

higher psychic activities now control the lower ones, and direct them to their own ends.

46. Play.—Play and imitation are the principal actions through which the psychic development of the younger child takes place. The play instinct is the craving for physical and psychic excitement with a relative indifference for its permanent product. Play actions include all that are not immediately necessary for the organism, are performed spontaneously, and give pleasure to the child. The play of a child lies in the direction of its future work and purpose. As interests and instincts develop in the child, they seek outward expression in the form of play. Play prepares the way for intelligent activity, and it is by means of play that the intellect gradually comes to replace instinct as the dominating principle of the child's life. The general purpose of play is the practice of the organs and functions. Play gives the child experience of the properties of objects, and at the same time strengthens and develops its powers. The pleasure that results from play is nature's invitation to the child to play. Practice in speech, the development of the imagination and the formation of fixed connections between representations of actions to be performed and these actions themselves are the principal functions that play develops in the child.

47. Imitation.—Imitation is a higher form of action than play because in imitation the child uses its organs to perform certain actions anticipated as representations. In imitative action, a person or object—especially one that is often associated with the child, or easily acquires such association in the imagination—first intensely ar-

rests the attention, and then excites the feelings and stimulates the imagination. This leads to the formation of motor associations in the brain, and the motor stimulus then travels to the organs of motion and innervates them to perform the imitative action. Imitation, like play, has neither specific stimulus nor specific reaction. It is based on inborn powers and tendencies, social conditions, and the development of the faculties. As the child grows, the type of persons it seeks to imitate changes with the child's interests; it tries to imitate more complex actions, and its imitative acts are more faithful to its model. The value of imitation lies in its preparation of the child for adult life, while it protects him from the dangers to which he would otherwise be exposed in acquiring such experiences. Imitating his parents, teachers, and friends, the child acquires their modes of expression and action, their emotions and mental attitudes. Thus, imitation is one of the social bonds that promote the progress of the race, especially through the establishment of schools. The application of the method of one science to another also is a process of imitation. Counter-imitation is a peculiar form of imitation in which one does the opposite of what another does. In the child, imitation finally leads to creative expression, which is again a higher form of expression. The joy of creation is the reason of the child's love for this form of action.

§ 5. ATTENTION

48. Description.—Some objects are merely present in our consciousness, others are noticed, and others again are carefully considered. These three acts

may be termed degrees of consciousness. They are intimately connected with attention, the chief characteristic of which is the concentration of our psychic activities on a content of consciousness, resulting in its clear, distinct, and usually vivid perception. Furthermore, when we consider a content of consciousness attentively, we not only remove all inhibitory influences and contents from our cognition, but also occupy ourselves in many special ways with the content to which we attend. Our will impels our cognitional faculties to intense action upon it, our mind seizes its details, we interpret it in the light of our previous knowledge, we consider its esthetic aspects, our feelings are moved by it, and our motor organs may grasp the object of our attention.

The psychological study of attention inquires into its properties, its cause and conditions, its effects, and its nature as an experience.

49. **Properties.**—Voluntariness or spontaneousness, intensity, extension, and fixity are the principal properties of attention.

(1) Attention is *spontaneous,* or reflex, when its object forces itself on the mind, as when we suddenly hear an alarming noise, or when an idea unexpectedly strikes us. Attention is *voluntary* when the mind seeks out or chooses its object and concentrates its activities on it, as when a problem is assigned to us for study. Attention that is spontaneous in the beginning, may become voluntary, or vice versa. Voluntary attention is more active, spontaneous attention more passive. The young child's attention is purely spontaneous.

(2) The *intensity* of attention is the degree of the mind's concentration on its object. Attention to an

object may become so absorbingly intense as to make us oblivious to all else. Two methods have been devised to measure the intensity of attention. *The method of disturbance* consists in projecting a gradually increasing disturbing or distracting influence into consciousness when it is concentrated on an object, and then measuring the amount of this influence required to diminish or to destroy the concentration. *The method of the double task* consists in assigning two tasks to be performed at one time, and measuring the degree of correctness with which they are performed. The difficulty of measuring the intensity of attention consists in finding and applying an objective standard to measure so subjective a phenomenon as attention, especially when the effect of the disturbing influence is counteracted by the will, and when the same stimulus has a variable effect in varying conditions. Intermittent and interesting disturbances are the most effective stimuli for diminishing attention. The usual stimuli applied in experiments conducted according to the method of disturbance are a simple stimulus of the senses, regularly recurring sounds, music, electrical stimuli, etc.

(3) The *extension* of attention is the number of objects attended to at one time. In favorable conditions an adult may clearly perceive six separate, simple letters, lines, or figures at one time. If the objects are presented to the attention in groups, as many as a hundred may be simultaneously perceived with clearness. In practical life, however, attention is not divided among so many objects, because those to which it is actually directed are quite complex. The extension of attention is usually inversely proportional to its intensity.

(4) The *fixity* of attention is its duration relative to its object. Attention rapidly diminishes and ceases when a simple object is considered for a long time. If one is easily fatigued, the attention quickly wanders. In the former case, the cessation of attention is due to the exhaustion of the accessible cognitional content of the object and to the dulling of our impressionability relative to objects to which we are accustomed; in the latter case, the cessation is due to our physical condition. Attention also fluctuates in regard to intensity, extension, and object, but the causes and laws of this fluctuation have not been determined with certainty. The rapidity with which attention can be shifted from one object to another varies greatly. Attention can be shifted in the same direction more easily and quickly than it can be changed from one direction to another. It can be directed from one detail of the same study to another more rapidly than from one science to another.

50. Causes and Conditions.—The intensity, novelty, habituation, and interest of the stimulus are the objective conditions that bring about attention. Subjectively, it depends on the absence of inhibitory processes, on the normal condition of the faculties, and especially on the will.

(1) Strong stimuli, such as a blinding flash of light, involuntarily compel our attention. Repeated stimulus, even though it is comparatively weak, draws the attention to itself. This is the psychology of moving advertising devices, of flickering safety lights, and of the constant repetition of the same slogan to bring about the realization, or possibly the illusion, that one needs the article displayed.

(2) Novelty and variety bring about attention.

The rural inhabitant is attracted by the novelty of the city and its ways, and the city dweller is drawn to brook, hill, and meadow. A polychrome picture attracts more attention than a monochrome drawing. We notice the tick of the clock the moment it stops, though we may not have attended to it for hours before.

(3) Habituation to a stimulus draws attention to it, not because of itself, but because of the connection of the stimulus with our feelings or interests. Thus the turfman is attracted by fine horses, the bookworm turns to his library, and the tired man seeks his accustomed chair and place.

(4) Interest, whether permanent or momentary, attracts our attention. Birds of a feather flock together, and misery loves company. Our interests are determined by our feelings and especially by our will. Objects that are in harmony with our interests attract our attention, because of the pleasure, satisfaction or advantage they afford us. The interest of self-preservation attracts our attention to remove objects threatening our welfare.

(5) When the attention is intensely engrossed in an object, this condition acts as an inhibitory process, preventing our attending to other objects which in themselves would be of equal interest to us. This fact is due to the narrowing of consciousness, or rather of attention, by reason of the limited amount of psychic energy available to us. In those cases in which the added perception of a second object intensifies our attention already directed to another, this phenomenon is due to the natural or merely associated connection between both objects, or to the creation or the intensification of a mood or other

psychic condition favoring the direction of attention to the first object.

(6) Organic conditions that facilitate attention are: (a) easy adaptation of the organ to the object; (b) general physical conditions facilitating the activity of our faculties, such as comfortable temperature, proper light, and normal atmospheric pressure; (c) stimulation of the system, as by drugs. These conditions have only a relative value in promoting attention, because they may be counteracted by psychic influences, such as fear, worry, and anger.

(7) The will is the most powerful single factor in creating or facilitating attention, though spontaneous attention may be so strong as to absorb all our psychic energy. A child may be so engrossed in play as to forget its hunger.

The action of the will in creating attention consists in bringing before our consciousness the idea of the object to which attention is to be directed, in removing every other object from it, and in adapting our organs for its perception. Often the will also brings up into consciousness a representation of the object, and a feeling of expectation comes over us. Tension of the muscles, cutaneous sensations, and organic sensations in the head, due to an increased supply of blood to the nerves, may accompany these processes.

The action of the will on the attention is particularly valuable when a difficult task is to be performed. In this case, attention naturally flags and wanders, and then the will brings about psychical and physical conditions that promote attention. Discouragement and eventual failure are averted by the will. Even when no visible results are achieved for

the time being, the will keeps the mind subconsciously at work on the task, and the good results appear at a later period.

51. Effects.—(1) The first effect of attention on the content of consciousness is to give it clearness and distinctness. Clearness is the perception of the details of the content; distinctness is its discernment from other contents. Objects remaining outside the focal idea are dimly perceived and vaguely distinguished from the others that are with them in the marginal process. For example, shades and qualities of tone that are clearly distinguished when attention is centered on them, are only vaguely distinguished if the attention is withdrawn. A chord is perceived as a group of indistinguishable sensations; but, if attention is concentrated on it, even its overtones are distinguished.

(2) Attention results in the establishment of many relations and associations between the focal idea and other objects perceived or remembered. The object of attention is classed with others of the same kind, as when children name the things they see. The mind further investigates the object, makes it the subject of numerous judgments, and establishes relations of similarity and dissimilarity.

(3) Objects that engage the attention are more quickly impressed on the memory, more surely, lastingly, and faithfully remembered, and more quickly recalled. Important experiences in our lives, such as our first journey, our first day at school, or our first lesson in a foreign language, are in after years accurately recalled with many details.

(4) The focal object entrains more numerous and vivid feelings than the objects in the marginal proc-

ess. These feelings are reducible to pleasure and pain, to attraction and repulsion. The objects on which attention is centered exert a strong influence on the character for good or evil, because the feelings with which they are associated become a powerful incitement to seek them again.

(5) Attention imparts a relative fixity to the direction of consciousness. When attention has been concentrated on an object, a certain resistance, or at least a hesitation, is experienced in the initial attempt to shift it to another object. This condition is a protection against the mental chaos that would result if our attention were by necessity fixed on all successive sensations appearing in our consciousness, and we were thus mentally tossed about by every current of perception. Well-disciplined voluntary attention has saved many from mental dissipation and an aimless existence of idle day-dreaming, from pursuit by haunting obsessions, and from depression through worry and anxiety.

(6) The adaption of the sense organs and of the posture of the body for the most favorable perception of the object are among the physical effects of attention. Respiration decreases, and the brain receives a more ample supply of blood. Fatigue results from protracted attention.

52. Anomalies.—Proper distribution for the attainment of the essential purposes of human existence is the ideal condition of attention. Too much or too little concentration is a defect. Excessive concentration is found in dementia præcox, in which the victim judges every attempt to bring necessary matters to his attention as a subterfuge to influence

his will, to domineer him, to meddle with his affairs, or to convict him of incompetence. Hence, he stoutly resists both the evidence of facts and the sound advice of his faithful counsellors. Depressive mania, on the contrary, brings with it the inability to concentrate readily despite the most intense effort. Vacillating and superficial attention, quickly shifting from one object to another without purpose and following sensations just as they present themselves, is found in children, paralytics, and persons suffering from senile dementia. Fatigue, somnolence, and narcotics render attention abnormally mobile and fluctuating.

53. Nature.—What psychic acts effect the clearness and the narrowing and direction of consciousness by which attention is characterized? This is the problem of the nature of attention, for the solution of which three groups of theories have been proposed. (1) Inhibition theories, according to which the undesired content is inhibited with the result that the content to which attention is given attains its clearness. However, inhibition cannot explain the clearness of a content that is in itself faint and indistinct, but receives a decided clearness through attention. (2) Preparation theories ascribe the clearness of the content to preparatory acts adapting the organs for the most favorable perception, bringing up the idea, the representation, and the expectation of the content, and providing a more ample supply of blood for the nerves. These theories have the same defects as the inhibition theories. (3) Facilitation theories explain attention by the formation of association tracts and by the variable excitability of the nerves and the organs. If the material

aspects of attention are satisfactorily explained in this way, the phenomena of spontaneous attention are not all sufficiently accounted for.

Another factor of attention must be sought in the voluntary direction of psychic energy to the object by the soul. The fundamental element in the complex experience that we term attention seems to be an original, underived act, not one produced by the combination or association of other acts. The nature of attention consists in the concentration of psychic activity on a content of consciousness. This act does not proceed from the will, because the most intense spontaneous attention is an undoubted fact—for example, that produced by a blinding flash of light or by a deafening noise. In such cases, the will begins to act only when we divert our attention from the object in order to continue our regular work. Furthermore, attention may persist despite the most extreme efforts of the will to avert it.

Collateral Reading.—James, *Principles of Psychology,* Vol. I, Chapter IX (The Stream of Thought); Maher, *Psychology,* Chapter XVII (Development of Intellectual Cognition); Moore, *Dynamic Psychology,* Part I, Chapters II–VI (Consciousness, The Unconscious, Methods of Investigation, Classification of Mental Processes); McDougall, *Introduction to Social Psychology,* Chapter IV (Play and Imitation); Seashore, *Introduction to Psychology,* Chapter IX (Attention).

Seashore, *Elementary Experiments in Psychology,* Chapter XIII (Attention); Snow, *Problems in Psychology,* Chapter IV (Attention).

CHAPTER IV

SENSATION IN GENERAL

§ 1. THE NATURE OF SENSATION

54. Conditions.—The sensation of an external object depends on several conditions. In order that we may see a tree, a physical activity must proceed from it. This is the stimulus that is received by the eye. The optic nerve then conducts the stimulus to the visual area of the brain. By this process our consciousness is acted upon in a way unknown to science, and its reaction is the visual sensation of the tree. Hence, the conditions of sensation are stimulation of the organ, excitement of the nerves, conduction of the excitement to the nerve centers, and the reaction of consciousness.

55. Sense Stimuli.—A sense stimulus is any form of energy that excites a sensory nerve and so causes sensation. Stimuli are divided into two general classes: (1) *external stimuli,* which are a form of energy outside the body; (2) *internal stimuli,* which originate in a sense organ or in the brain. External stimuli are only the mediate cause of sensation, because, in order to effect it, they must be transformed into internal stimuli in the organ of sensation. External stimuli are subdivided into *general stimuli* (which act on more than one sense) and *special* or

specific stimuli (which act only on one sense). The general stimuli are mechanical, thermal, chemical, and electrical. Electricity is a general stimulus, because it produces cutaneous, gustatory, and visual sensations. Light waves are a special stimulus, because they act only on the eye. Internal stimuli originate in the sense organ or in the brain; the former are termed *peripheral,* the latter *central stimuli.*

In order to produce sensation, the stimulus must be conducted to the brain. It is not sufficient that the sense organ be excited. If conduction is interrupted by severing or paralyzing the nerve, no sensation follows. The nerve excitement is conducted to an entire area of the brain (such as the visual or the auditory area), not to a single cell.

Sensation is not always strictly proportional to the stimulus, for the receptivity of the organ varies with its general condition, and only those stimuli that fall within the stimulus scope produce a normal psychic effect.

56. Description.—Sensation is the most elementary cognitional process. It makes known to us the properties of the objects that stimulate our senses. A simple visual sensation is produced if we are in a completely darkened room, no part of which reflects light, and an electric flash is seen. But, if we ring a bell, we see its color, motion, and extension, hear its sound, and feel its weight, extension, temperature, and vibrations. This is a complex group of sensations, some of which differ from each other in kind, and all of which differ from the perceptions, representations, ideas, and acts of attitude to which the object simultaneously gives rise in us.

Sensation is not a physical nor a physiological process in the sense organ or in the brain. Such processes are prerequisites and causes of sensation. They are transformed by the sense faculty into psychic stimulus, the reaction to which is sensation. The brain is not the subject of the content of consciousness, because its processes are known only through logical inference and not immediately perceived, and because the content of consciousness does not always correspond to the stimulus. The cognitional determinant of sensation must be psychical, for its effect is psychical. On the other hand, the soul is not the cause of the excitation of the sensory nerves, because there is no sufficient reason in the soul why it should produce a given sensation at a given moment.

The sensory faculty is passive in receiving the stimulus, but its psychic transformation of the stimulus and its reaction to it is a subjective activity conditioned by the stimulus. Hence, sensation is not "creative" like the imagination, for it apprehends only an existing object, represents it only in the manner in which it exists, and is not subject to the control of reason. Sensation is merely the immediate sensible reaction of consciousness to an external stimulus.

§ 2. THE PROPERTIES OF SENSATION

57. Properties.—Considered from its objective aspect, sensation has the properties of quality and intensity, besides spatial and temporal properties. These properties belong to sensation considered as a content of consciousness, as representing a property of an object, but not to its subjective aspect as

a psychic activity. Not the act of the sensory faculty is loud, blue, or bitter, but our sensation is that of an object possessing these qualities. Similarly, it is not sensation, but its object, that is extended.

Quality and duration are essential to all sensations; intensity and extension are not found in all classes. The properties of sensations may be modified independently of one another, but none that belong to a given class of sensations can be entirely absent from it when the sensation is present. The duration of a tone may be varied without otherwise altering it, but pitch remains inseparable from it. The quality of colors may be changed, but it cannot be entirely removed without terminating the sensation of color. Color has no absolute, but only a relative intensity. Odors have no extension. The ability to perceive variations in the properties of sensations is limited and not uniform. Minute fractional variations of tone are imperceptible, and the keenness of the senses varies in different persons.

58. Quality.—The quality of sensations is their characteristic kind of reaction to specific stimuli. In relation to one another, the qualities of sensations are either (a) *disparate,* that is, they belong to different classes (such as color and sound), or (b) *related* (that is, specifically different within the same class, such as blue and green).

59. Intensity.—The intensity of a sensation is the degree in which it verifies its type of quality. A loud sound is more intense than a faint sound, and stifling heat is more intense than comfortable warmth.

The sense organs are so constructed that there is both an upper and a lower limit of the intensity of

sensation, and consequently of effective stimulus. The stimulus threshold is the least amount of stimulus necessary to produce sensation. The measure of receptivity is the maximum stimulus that is still able to increase the intensity of sensation. If the stimulus exceeds the measure of receptivity, it fails to increase the intensity of the sensation, and it may injure the sense organ. If the stimulus falls below the threshold, it produces no conscious effect. The stimulus scope is the range of stimulus between the stimulus threshold and the measure of receptivity. Between these two extremes the stimulus may be indefinitely varied, but not every variation is perceptible as such. The least increment of stimulus required to produce a just noticeable difference in the resulting sensations is called the difference threshold. The upper and lower limit of the stimulus that is capable of producing a just noticeable difference in sensation is the limiting threshold.

The threshold is not a constant unit. It varies not only in different persons, but also in different physical and psychic conditions of the same person.

(a) The excitability of the sense organ varies. Sensibility to pressure varies in different places of the skin, and moderate light blinds one coming from a darkened room.

(b) Diffusion of the stimulus produces a more intense sensation, as in the case of an odor.

(c) Attention to a given stimulus may increase or diminish the perception of a new and different stimulus (see Section 51).

(d) Long duration and repetition of a stimulus may intensify or dull our sensibility to it. A regularly repeated sound may be more intensely per-

ceived, but its constant repetition may also render it unperceived. The ticking of a clock may pass unnoticed and unperceived, but an unusual noise is keenly perceived when repeated.

(e) Expectation of a sensation intensifies our sensibility to it. When we search out a friend in a crowd, a fleeting glimpse of him is intensely perceived.

(f) Practice intensifies the perception and discrimination of stimuli. A practiced eye is able to distinguish slight variations of color unnoticeable by untrained senses. A musician perceives and clearly distinguishes overtones of which the average listener remains unaware.

(g) Fatigue dulls our sensibility by producing a toxic condition of the nerves.

§ 3. GENERAL LAWS OF SENSATION

60. Scope.—Just as the law of specific sense energy states the relation between the stimulus and the quality of sensation, so Weber's and Fechner's laws seek to determine the relation between the intensity of the stimulus and that of the resultant sensation. The solution of this problem is unusually difficult, because it is impossible to determine the absolute intensity of sensations. There is no doubt as to the variability of the intensity of sensations in general. The real difficulty lies in the measurement of these psychic units. Visual and auditory stimuli vary in intensity, but these variations do not directly correspond to the variations in the intensity of the sensations they produce. If one is lifting a one-pound weight, the addition of another pound to it produces

a marked increase in the intensity of the resultant sensation of pressure; but if one is lifting a fifty-pound weight, the addition of another pound does not produce a corresponding increase in the intensity of the sensation previously experienced. Weber's and Fechner's laws endeavor to determine the relation of the increase in the resultant sensation to that of the stimulus.

61. Weber's Law.—Not every variation of the stimulus produces a noticeable difference in the corresponding sensation. If one is lifting a one-pound weight, the addition of a small fraction of an ounce to it does not produce a noticeable difference in sensation; but, if small weights are gradually added to the original one-pound weight until they total several ounces, there is a noticeable difference in the sensation. If a room is lighted by a single candle, the addition of another candle noticeably increases the light; but, if a thousand candles are already lighted in the room, the addition of another candle does not noticeably increase the light. Hence, the addition of the same stimulus to another already present produces a different effect in different conditions. E. H. Weber (1795-1878), professor of physiology in the University of Leipzig, studied the relation of the increase in sensation to that of the stimulus in auditory and cutaneous sensations, and in 1834 stated the result of his investigations in the following formula: "The difference in sensation remains the same if the relative difference, or the relation, between the stimuli remains the same."

What is the meaning of Weber's law? It does not measure the intensity of any sensation, because it does not state which multiple of a given sensation

any other given sensation is. Weber's law compares a series of sensations with one another, estimates the difference in intensity that we notice in them, and compares this difference with the difference between the stimuli that cause these sensations. If we have a series of three auditory sensations, Weber's law tells us that the difference in intensity between the second and third is the same—whether great or small—as that between the first and second, provided that the stimulus causing the third sensation has the same proportional relation to that causing the second as the stimulus causing the second has to that causing the first. If the stimulus causing the first sensation has the hypothetical strength of 10, and that causing the second has the strength of 20, then the difference between the first and second, and between the second and third sensation will be equal—no quantitative estimate of the difference is attempted—provided that the stimulus causing the third sensation has the strength of 40. Since the second stimulus is double the first, the third stimulus, in order to have the same relation to the second as this has to the first, must be double the second—that is, 40. If the first stimulus has the strength of 10 and the second that of 30, the third must have the strength of 90. If the first is equivalent to 10 and the second to 50, the third must be 250. Weber confined his investigations to auditory and cutaneous sensations in the middle region of the stimulus scope. Not realizing the full import of his discovery, he considered it merely an interesting psychological phenomenon.

62. **Fechner's Law.**—C. T. Fechner (1801-87), professor of physics in the University of Leipzig, took up the same investigations without knowing Weber's

work. Subsequently he named his colleague's discovery *Weber's Law,* but continued his own "search for a standard for the measurement of sensibility." He sought a mathematical formula for the measurement of the intensity of sensation. He summed up his long and painstaking researches in the formula known as *Fechner's Law*: "A relatively equal increase of stimuli effects an absolutely equal increase in the intensity of sensation. Stimuli are relatively equal when they have the same mathematical relation: if the first stimulus has the strength of 10, and the second has double this amount, the third must have double the second, etc., yielding the series 10, 20, 40, 80." This statement is identical with Weber's law. But Fechner goes beyond Weber in asserting and determining a quantitative relation in the resulting sensations. Thus, the sensations caused by the above stimuli will have the following relations: if the first has one degree of intensity, the second has two degrees, the third three degrees, etc., yielding the series 1, 2, 3, 4.

63. Validity of Weber's and Fechner's Laws.— Wundt and others continued the researches of Weber and Fechner, testing their applicability to the different qualities of sensations, and seeking especially to determine the stimulus threshold and the threshold of discrimination. Their experiments showed that Weber's law is valid in regard to sensations of sound, light, pressure, and tension; but it has not been verified for sensations of taste, smell, and temperature. Weber's law is approximately correct for the middle region of the stimulus scope of the sensations mentioned, in the sense that, when the proximate members of a series of stimuli stand in the

same relation to each other, the difference in the intensity of the corresponding series of sensations is *perceived* as being equal.

A remarkable confirmation of Weber's law was found by the measurement of star light. The old empirical classification of stars according to equal differences in luminosity, as estimated by astronomers, bears out approximately the difference of their light stimulus as calculated by Weber's law and recorded by photochemical measurement.

The verification of Fechner's law encounters serious difficulties. Fechner sought a mathematical formula for the measurement of differences in the intensity of sensation. His method consisted in applying a minimal stimulus to the sense organ and gradually increasing it until it reached the stimulus threshold. The corresponding sensation was recorded as having one degree of intensity. Then the stimulus was further increased until the threshold of discrimination was reached. The resulting sensation was recorded as possessing two degrees of intensity. In this way the series of stimuli and of sensations was obtained. Later investigators have devised other methods for the study of the problem.

The objections against this method of experiment are: (1) it presupposes that all just noticeable differences of sensation are equal. This is uncertain, because on account of the extent, or breadth, of the limiting limen, differences may be *perceived* as equal without actually being so; (2) it presupposes that sensation is a measurable unit. The difference between the intensity of sensations, rather than the intensity itself, is measurable, for sensations cannot

be divided into units and thus compared for measurement.

64. Theories.—Several theories have been proposed to explain the relation between the increase of stimulus and of sensation as formulated by Weber and Fechner.

(1) Fechner terms his own explanation the psychophysical theory. In his view the excitation of the nerves is directly proportional to the sense stimulus, but the transfer of the increased intensity of excitation from the brain to the soul requires a constantly increasing amount of brain energy in order to increase the excitation of the soul, in which sensation is the "spiritual reflection" of nerve excitement. Fechner had practically no followers in this explanation. Incidentally, the "spiritual reflection" of which he speaks is merely a clever metaphor.

(2) According to the psychological theory proposed by Wundt, sensation is directly proportional to the stimulus, but we are unable to perceive this condition, because, when we compare two sensations to determine their intensity, they become assimilated to each other by apperception.

(3) The physiological theory of G. E. Müller ascribes the diminution in the psychic effect of the stimulus to the resistance of the nerves, which the stimulus must overcome. The relatively greater stimulus required for very intense sensations is accounted for by the dulling of the sensibility of the nerves by powerful stimuli. This appears to be the more probable explanation.

Whatever the explanation of the fact expressed by Weber's law, the diminished psychic effect of the

increased intensity of the stimulus and the existence of a limiting limen that broadens with the intensity of the stimulus, constitute another admirable teleological arrangement of the organism, adapting it to its environment so as to serve the purposes of human life. The perception of a number of just noticeable differences is the means that nature has given us to distinguish objects by the sense of sight. If the visual sense perceived all the minute fluctuations of light that are constantly occurring, we would be much confused in identifying objects. But, since these slight variations remain undistinguished in our perception because of the range of the limiting limen, we are not subject to the difficulties that would arise for us through a more keen sense of vision.

Collateral Reading.—MERCIER, *Manual of Modern Scholastic Philosophy,* Vol. I, pp. 187–208 (Sensation); MAHER, *Psychology,* Chapter IV (Sensation); JAMES, *Principles of Psychology,* Vol. I, Chapter XIII (Discrimination and Comparison); WARREN, *Human Psychology,* pp. 215–25 (Sensations); PYNE, *The Mind,* Section 16 (Nature and Principle of Sensation).

SEASHORE, *Elementary Experiments in Psychology,* Chapter VIII (Weber's Law).

CHAPTER V

THE VARIOUS CLASSES OF SENSATIONS[1]

65. Classification.—The ancients were accustomed to classify sensations according to the external sense organs. They distinguished sight, hearing, taste, smell, and touch. This principle of classification is not satisfactory from a scientific point of view, since sensations are different only when they do not go over into one another. Quality as the criterion of distinction is applied with difficulty to a considerable number of sensations, because they are so intimately bound up with feelings and experiential interpretations that it is difficult to isolate, analyze, and compare them.

A modified form of the ancient classification of sensations will be satisfactory for the requirements of a general investigation of the subject. The most general division of sensations is that into *internal* sensations, which give us knowledge of our physical conditions, and *external* sensations, which make the external world known to us. What the ancients called the sense of touch is really the skin sense,

[1] See the glossary at the end of the book for definitions of technical terms.

which has four distinct kinds of sensations. Thus, the following table results:

I. External sensations (stimulus from without the body):

- visual
  - black-white series
  - blue-yellow "
  - red-green "
- auditory
  - tones
  - noises
- olfactory
  - etherial
  - aromatic
  - balsamic
  - amber-musk
  - allyl-cacodyl
  - burning
  - caprylic
  - repulsive
  - nauseating
- gustatory
  - sweet
  - sour
  - salt
  - bitter
- cutaneous
  - pressure
  - heat
  - cold
  - pain

II. Internal sensations (stimulus from within the body):

- common sensibility
  - pressure
  - heat
  - cold
  - pain
- kinesthetic sensations
  - muscular
  - articular
  - tendinous
  - static
- organic sensations
  - circulation
  - respiration
  - digestion
  - etc.

§ 1. VISUAL SENSATIONS

66. The Eye.—The eyeball consists of three concentric coats, the sclerotic, the choroid, and the retina; and of the three translucent, refracting bodies, the aqueous humor, the lens, and the vitreous humor, enclosed within them.

67. The Coats.—(1) *The Sclerotic Coat.* The outer or protective coat is a strong, opaque, fibrous structure of connective tissue maintained at a certain degree of tension by the pressure of the fluid contents of the eyeball. The cornea is the transparent forepart of the sclerotic, which admits light into the eyeball.

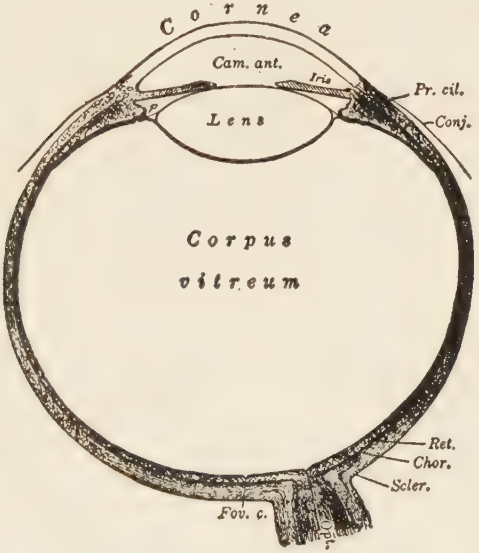

FIG. 6. THE EYE.

(2) *The Choroid Coat.*—The second or vascular coat lies immediately within the sclerotic, and consists mainly of blood-vessels united by connective tissue. It consists of two parts, the choroid proper and the iris. The choroid proper is applied to the inner surface of the sclerotic by a few connective fibers, nerves, and blood-vessels. The lymph space left between these two coats enables the choroid to move on the sclerotic. The choroid is firmly attached to

the retina. The iris is the contractile, colored membrane fixed to the choroid at its circumference, but otherwise floating freely in the aqueous humor just in front of the lens, with which it is lightly in contact. The iris is separated from the cornea by the depth of the anterior chamber of the eyeball. The center of the iris is perforated by an aperture called the pupil. The expansion and contraction of the pupil is a reflex that adapts it to the light and to the distance of the object seen. The greatest expansion of the pupil admits about forty times as much light into the eye as its maximum contraction.

(3) *The Retina.*—The visual coat of the eye is a delicate membrane which contains the expanded termination of the optic nerve. It is just within the choroid coat and rests on the hyaloid membrane of the vitreous humor. It extends forward to the outer edge of the ciliary process of the choroid, where it ends in an indented border.

68. Refracting Bodies.—(1) The *vitreous body* occupies about four-fifths of the eyeball. It is a transparent, gelatinous substance, consisting of about 98.5 per cent of water. The vitreous body serves as a support for the retina, and possesses a depression in front to receive the lens. Its entire periphery is covered by the hyaloid membrane.

(2) The *lens* is an elastic, transparent, bi-convex body, enclosed in an elastic, transparent, structureless membrane called the capsule. Its anterior surface is in contact with the aqueous humor, except where the iris rests on it. The lens measures 8 to 9 millimeters across, and 3.6 to 4 millimeters from front to back, according to its accommodation. The lens is suspended and held in position by many

strong fibers, which proceed from its equator to the ciliary process of the choroid.

(3) The *aqueous humor* is a clear lymphoid liquid, which occupies the forepart of the eyeball between the lens and the cornea. The iris, which rests partly on the lens, divides the aqueous humor into an anterior and a posterior part.

69. The Retina.—Roughly speaking, the retina is extended like a hollow hemisphere between the choroid coat and the hyaloid membrane of the vitreous body, as far forward as the outer edge of the ciliary process of the choroid. A vertical section of the retina reveals eight strata, united by fibrous connective tissue. The ganglion cells, the rods and cones, and the inner nuclear cells are the principal strata of the retina.

The *ganglion cells* are distributed through the retina in a single layer next to the stratum of the nerve fibers bordering on the inner sustaining tissue. But in the yellow spot they are two or three layers deep, very densely set, and smaller than in the other parts of the retina.

The *rod-and-cone cells* are the seventh stratum toward the outside of the retina. They are arranged in several layers, and the rods and cones are turned toward the pigment cells, which form the outside stratum of the retina. The rods have an elongated cylindrical form. The cones are bottle-shaped.

70. The Blind Spot and the Yellow Spot.—In these two places the structure of the retina presents characteristic differences from the general description given above. The optic disk is the point where the optic nerve enters the retina and expands to form its inner stratum. It is about 1.5 mm. in diameter,

and contains only nerve fibers and blood-vessels. Since it lacks the other retinal structures, it is insensible to light stimulus, and is therefore called the blind spot.

FIG. 7. VERTICAL SECTION OF THE RETINA.

1, inner limiting membrane. 2, layer of nerve fibers. 3, layer of nerve cells. 4, inner molecular layer. 5, inner nuclear layer. 6, outer molecular layer. 7, outer nuclear layer. 8, outer limiting membrane. 9, layer of rods and cones. 10, layer of pigment cells.

Near the axis of the eyeball, about 3 mm. from the optic disk, lies the yellow spot, which is the area of most acute vision. It is about 2 mm. in diameter. In the center of the yellow spot lies the central fovea, which is a slight depression about 0.2 to 0.4 mm. in diameter.

71. Visual Sensations.—Visual sensations are either colorless or color sensations. The colorless group ranges from blinding white through all degrees of gray to the deepest black. The sensation of white results either from a combination of color stimuli or from extreme intensity of a single stimulus. Black is a positive sensation, which results from the lack of dark adaptation of the retina after the removal of stimulation by white light. Very weak color stimuli are perceived as belonging to the black-and-white series. Blindness results in a sensation of gray, not of black. Black is caused by a temporary condition of the cerebro-retinal apparatus, not by an external stimulus. The gray light perceived when the eyes are closed, is not the

intrinsic light of the retina, because it persists after section or atrophy of the optic nerve.

72. Properties.—Color sensations have the properties of hue, saturation, and brightness. Hue is the specific quality of the color sensation. It ranges from red (which is excited by the longest ether waves) to violet (which is excited by the shortest). Saturation is the purity of the hue as measured by the absence of an admixture of white light. The colors from the spectrum are more highly saturated than those from other external stimuli. The degree of saturation is determined by comparison with other colors of the same hue. The brightness of a color is its luminosity, or approach to white light. Yellow is the brightest and blue the darkest color, but the relative brightness of colors varies with the degree of illumination. Red and yellow are dimmed in twilight, but green and blue are comparatively bright.

73. Color-Blindness.—There are three forms of congenital color-blindness: red-green, yellow-blue, and total color-blindness. The first occurs in about 4 per cent of males, but is rare in women; yet, the latter transmit it almost exclusively through their daughters. There are two types of red-green blindness. The one sees the spectrum in the same length as the normal eye, and the point of maximal brightness is about the same, but red and green appear as gray. For the second type, the red end of the spectrum is darker than for normal vision, extreme red is invisible, and the maximal point of brightness is nearer green. Yellow-blue and total color-blindness are rare. In all cases of color-blindness the unper-

ceived colors appear as a gray band of varying brightness. There are also two types of total color-blindness, the one perceiving maximum brightness in the yellow and the other in the green region. Acquired color-blindness is caused by the prolonged action of colored light upon the retina, the use of drugs, or disease. It differs in many respects from congenital color-blindness: red-green, yellow-blue, in the above senses, there is also weak color vision, in which there is greater adaptation and contrast of color and slowness in distinguishing certain colors. Anomalous color vision is principally green-weak and red-weak.

74. Color Mixtures.—The eye always perceives qualitatively simple colors, but the stimuli that cause these sensations may be simple or composite. When light stimuli of different wave lengths strike the retina simultaneously, they cause a simple visual sensation. The laws of color mixtures state the relation of this resultant color to the colors that result from the separate action of these stimuli on the retina.

The eye differs from the ear in not being able to analyze light as the ear analyzes sounds. This, again, is a teleological arrangement, not an imperfection; for, if the eye were to decompose light, we would not see objects as white or colored, but only a confused medley of colors.

75. After-Images.—A visual sensation is conditioned by other visual sensations that have immediately preceded it at the same point in the retina. Hence, it does not in this case precisely correspond to its stimulus. When the action of light on the retina begins, a period of from about 0.07 to 0.16 sec-

onds, depending on the spectral color, elapses before the visual sensation attains its full intensity. After the stimulus has been removed, the sensation remains for a somewhat longer period. Thus, visual sensation comprises three phases, rise, culmination, and fall. This condition is due to the structure of the visual sense and its manner of functioning.

The after-image is the image of a visual object that appears after the stimulus has ceased. After-images explain the continuity of sensation produced by moving pictures, the sensation of a fiery streak produced by a rapidly moving light, etc. The intensity, sharpness, and persistence of after-images depend on the strength of the stimulus, not on its duration. A momentary glance into the sun produces an after-image of considerable duration, but a long steady look into a weak light results in an after-image of negligible duration.

After-images are positive and negative. A positive after-image is one that retains the color and shade of the original sensation, usually with diminished purity and brightness. Charpentier calculates the duration of positive after-images under various conditions of illumination and duration of the stimulus as follows: (1) if the duration of the stimuli is identical, the duration of the positive after-image varies inversely as the square root of the illumination; (2) if the illumination is identical, the duration of the positive after-image varies inversely as the square root of the duration of the stimulus.

A negative after-image is one that is changed or reversed in color, as compared with the original sensation. Negative after-images are experienced when a light object on a dark ground is fixated for about

half a minute, and the eye is then turned to a uniformly bright surface. The bright object now appears as a dark area on the bright surface, retaining more or less of the outlines and details of the original image.

76. Retinal Adaptation.—The light and dark adaptations of the retina are well known from everyday experience. When we come from good light into darkness, we see poorly at first. During the first ten minutes, our retinal adaptation to the darkness increases slowly; during the next twenty to thirty minutes, it increases rapidly; and during the following half hour, it increases slowly until the maximum of adaptation has been reached.

On suddenly coming from darkness into bright light, we are at first dazzled, so that we are unable to see objects distinctly. Good vision is established within a few minutes. In the light-adapted eye the center of the retina is the most sensitive part. This agrees with the theory that the rods are the receptors in scotoptic, and the cones the receptors in photoptic vision. The lesser variability in the sensitivity of the center of the retina protects us against the difficulties that would otherwise be caused by the objective fluctuations of light.

77. Color Contrast.—Color contrast is the alteration of visual sensation reciprocally produced by two colors viewed simultaneously or successively in distinct, adjacent areas. The color that causes the alteration is called the inducing color; the altered color it causes is termed the induced, or contrast color.

Successive contrast results from the projection of the positive or negative after-image on a dissimilar

background. Generally speaking, the contrasting color-sensation obtained is that which must be mixed with the color of the positive or negative after-image to obtain the given background. Thus, the positive after-image of red yields blue-green when it is projected on a white ground. If blue-green, the negative after-image of red, is projected on a violet background, the resulting contrast color is blue. The reason of this phenomenon lies in the lessened sensibility of the eye for the continued perception of the first color, and its favorable condition for the perception of the resulting contrast color.

Simultaneous contrast is obtained by placing two visual objects beside each other, or by surrounding one by the other. Gray placed on a colored background acquires a tinge of the complementary color of the background. But if the gray itself already possesses a tinge of color, the resulting contrast color follows the general laws of color mixtures. If the two contrasted colors are complementary, no change in hue results, but the saturation of each is increased. Contrasted colors of the same hue, differing in brightness and saturation, have a tendency to blunt each other; and if the saturation of one of them is very slight, it may be neutralized or change into its complementary color.

The effects of contrast are most marked when both colors lie in the same plane, are immediately adjacent, and are identical in surface, texture, etc. Marginal contrast—that is, the phenomenon of contrast as observed in the adjacent margins of the two colors—is the most pronounced. Contrast is increased by surrounding a small area by a large background. The contrast of pale colors is made plainer

by superinducing a transparent gray field over them. The contrast in brightness is directly proportioned to the difference between the brightness of the two contrasting colors—that is, the increase or diminution of brightness induced into either one of the contrasted colors, is equal to the difference in brightness found between the colors. Similarly, an increase in the saturation of the inducing color effects increased saturation in the contrasted color. These are the principal phenomena of the sensations of color contrast.

78. Theories of Color Vision.—The first modern theory of visual sensation that found wide acceptance was proposed by Thomas Young in 1807 in his *Lectures on Natural Philosophy*. It was taken up again by Helmholz in 1852, and later in his *Physiological Optics* (1856-66). Other investigators have developed and modified it in various ways. According to Helmholz, there are three kinds of retinal excitement, all of which are produced in relatively different degrees of intensity by every ray of light stimulus according to its wave length. When the excitement is conducted to the brain, three fundamentally different visual sensations result, namely, red, green, and violet (blue, according to others). All color sensations result from combinations of these three excitements, and the quality of the resulting color is determined by the predominance of one of them. Pure red, green, or violet results from the excessive predominance of the corresponding excitement. White results from equal intensity of all. Complementary after-images result from fatigue of the receptor elements in the retina that are excited

by the predominating stimulus. Color-blindness is due to the lack of the corresponding receptors.

The Young-Helmholz theory of color vision is untenable for the following reasons:

(1) it does not explain colorless sensations. All color-blind persons perceive white. Now, according to Helmholz, color-blindness is due to the lack of one kind of receptors, but on the other hand the sensation of white can result only from equally intense excitement of the three kinds of receptors corresponding to the three kinds of excitement. Nor does this theory explain the sensation of black;

(2) it is experimentally demonstrated that many secondary colors result from the combination of two primary colors. According to Helmholz, they must be combinations of three;

(3) complementary after-images actually increase in distinctness for some time after they have begun. According to Helmholz, they should diminish continuously as the organ recovers from fatigue.

The theory of Helmholz was succeeded by that of Hering, the basic conceptions of which were first published in his *Contributions toward the Theory of the Light Sense* (1874). Hering states that there are six fundamental visual sensations: white, black, red, green, yellow, and blue. They are not isolated from one another, but proceed from three different kinds of photochemical visual substances in the retina. One of these substances gives rise to the white-black series of sensations, another to the red and green, and another to the yellow and blue sensations. In each of the three visual substances a simultaneous process of assimilation and dissimila-

tion takes place. When the process of assimilation predominates, we have white, red, and yellow sensations; when the process of dissimilation predominates, we have sensations of black, green, and blue. When assimilation and dissimilation are balanced in the white-black substance, we have a sensation of gray; when they are balanced in the red-green or in the yellow-blue substance, these colors neutralize each other, and we have a sensation of white. Since there is a greater amount of achromatic (white-black) than of chromatic (red-green and yellow-blue) visual substance in the retina, changes in the colorless series of sensations are more prominent than in the color series, and both groups are usually associated together in our visual sensations. All light waves cause dissimilation of the white-black substance in varying degrees according to their length. The same light stimulus causes lighter or darker, colored or colorless sensations, because the psychic result of the excitation depends, not only on the stimulus, but also on the functional condition of the visual substances of the retina. Color-blindness is either red-green, yellow-blue, or total, according to the absence of one or all of the visual substances.

This theory affords a good explanation of color-mixtures, contrast, adaptation, negative after-images, and black sensations. It fails to explain the two types of red-green color-blindness. It assigns no sufficient reason for the opposite effects of the balance of assimilation and dissimilation in the chromatic and the achromatic visual substances. It also fails to explain why two areas of identical white light produced by different color mixtures do

not retain their identity when the illumination changes.

In 1866 Max Schultze proposed the "duplicity theory" for the explanation of chromatic and achromatic sensations. In 1894 the researches of von Kries gave it a broader foundation, and its fundamentals may be considered as established. Its central truth is that the cones are the receptors for light- and color-vision, and the rods for colorless vision. It is based on the observation that the rods are lacking and cones only are found in the central fovea, which is the area of the most perfect color- and light-vision; and that the rods increase in number and far exceed the cones toward the outer edge of the retina, which is the area of colorless vision. Furthermore, the cones are absent from the retina of certain nocturnal animals, such as bats, moles, hedgehogs, and certain rodents, and are few in certain night birds. On the other hand, the cones are very numerous in the retina of day birds and present almost to the exclusion of the rods in the retina of certain reptiles, such as snakes and lizards, which prefer the direct rays of the sun.

79. Retrospect.—The phenomena of visual sensations show that, both from their physiological and their psychic aspects, these sensations are very complicated processes. In their physiological aspects, which alone are subject to direct experimental investigation, the phenomenon of Purkinje shows their dependence on the intensity of the stimulus; the laws of color mixtures indicate their connection with the composition of the stimulus; color contrast discloses how they are conditioned by the spatial distribution of the stimulus; adaptation and after-

images reveal that they are contingent on the temporal relations of the stimuli.

§ 2. AUDITORY SENSATIONS

80. The Ear.—The ear is the most complicated of all the senses. It consists of a number of recesses and narrow canals, located deep in the bone. The common purpose of this complex system of passages seems to be to collect and concentrate all

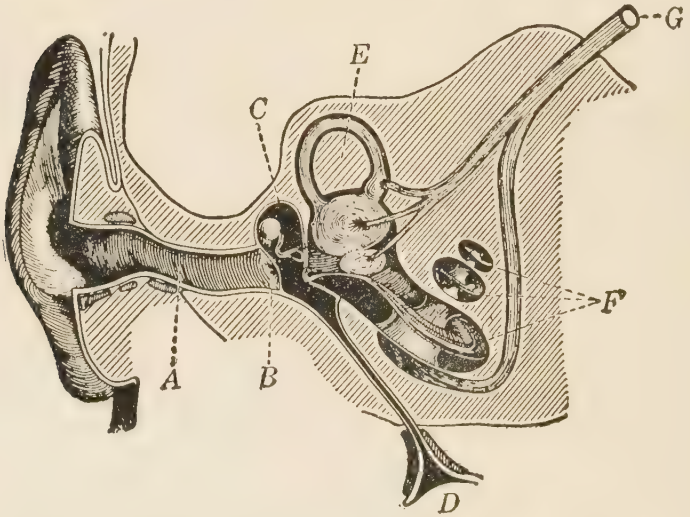

FIG. 8. THE EAR.

A, external auditory canal. *B*, tympanic membrane. *C*, auditory ossicles (hammer, anvil, stirrup). *D*, Eustachian tube. *E*, semicircular canals. *F*, cochlea. *G*, acoustic nerve.

kinds of sounds from all directions, to simplify and direct them in definite ways, and then to apply them to the auditory nerve. The ear consists of three parts: the outer ear, which collects the sound; the middle ear, which transmits it; and the inner ear, or labyrinth, which is the essential organ of hearing.

The external ear consists of the auricle and the external auditory canal extending from the auricle to the membrane of the tympanum.

The middle ear consists of three main portions: the Eustachian tube (communicating with the nasopharynx), the tympanum (which lies between the external and the internal ear, and is traversed by a chain of small bones), and the mastoid cavity (which lies behind the tympanum and communicates with the mastoid cells by means of numerous apertures).

The tympanum is an irregular, hollow, bony air chamber. It contains the auditory ossicles, three small bones familiarly known as hammer, anvil, and stirrup; the oval window, which is closed by a membrane attached to the base of the stirrup; and the round window, which is also closed by a membrane connected with the scala tympani (the lower chamber of the spiral tube of the cochlea). The tympanum is closed on the outside, and separated from the external ear by the tympanic membrane.

The first function of the middle ear is to concentrate the vibrations coming from without on the small area of the tympanic membrane, which transmits them faithfully to the ossicles, without reinforcing or altering their overtones by its own vibrations. The ossicles damp the vibrations received from the tympanum, reduce their amplitude, and convey them to the inner ear.

The inner ear consists of the bony and the membranous labyrinth. The bony labyrinth is divided into the vestibule, three semicircular canals, and the cochlea. It contains a clear fluid named perilymph. Within the bony labyrinth, and separated

from it by the perilymph, lies the membranous labyrinth, which in a general way has the same form as the bony labyrinth. The membranous labyrinth is filled with a clear fluid, called the endolymph.

The bony labyrinth is horizontally divided into an upper and lower chamber, the scala vestibuli and the scala tympani, which wind along its entire length in the form of a spiral. The lower side of the outer section of the wall separating the two chambers of the bony labyrinth contains the basilar membrane and the organ of Corti.

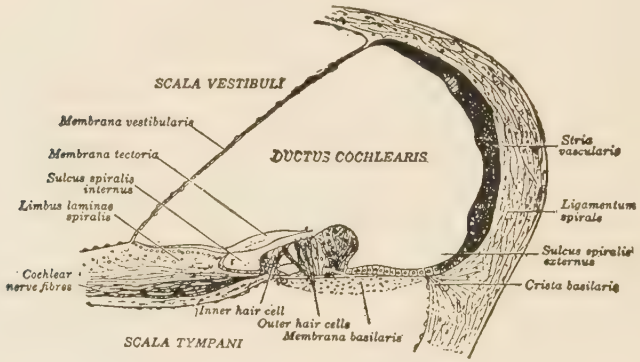

FIG. 9. THE ORGAN OF CORTI.

81. The Organ of Corti.—A system of highly specialized structures, called the organ of Corti, are mounted in the epithelium of the basilar membrane. The central part of this structure consists of two sets of rods, placed somewhat apart at the base, and inclining toward each other at the top, thus forming a pointed arch. The rods are set closely side by side along the whole length of the basilar membrane, and so form a tunnel. Outside the inner series of rods, a single row of hair cells, called the

inner hair cells, projects through the reticular lamina, a cuticular membrane that covers this part of the organ of Corti like a wire net. The hair cells are topped by an end-brush of fine, short, stiff hairs. Outside the outer series of rods, three or four rows of similar *outer hair cells* are found.

The function of the cochlear structures is to transmit the auditory stimulus from the stirrup to the acoustic nerve. The movement of the stirrup is communicated through the membrane of the window of the vestibule to the perilymph in a horizontal direction, and thus transmitted to the fibers of the basilar membrane, the organ of Corti, and thence to the acoustic nerve. Those fibers of the basilar membrane of which the vibration period corresponds to that of the auditory stimulus are set in motion by it relatively independently of the remaining fibers. This is possible because they radiate independently of one another from their base, and continually increase in length toward the top of the cochlea. Hence, the basic function of the cochlear structures is the transformation of the external stimulus into a movement of the various parts of the basilar membrane, whence it passes to the acoustic nerve and to the brain, and is psychically transformed into auditory sensation.

82. Classification of Auditory Sensations.—Auditory sensations are commonly classified into tones (or musical sounds) and noises. A *tone* is a sound produced by regular vibrations. It is not established whether *noises* are specifically different sounds from tones, or whether they are caused by the summation of irregular and unblending vibra-

tions. In everyday life, tones and noises are usually associated in varying proportions. Thus, we distinguish the tones of a violin from the scratching of the bow, and we may hear distinct noises in the howling of the storm. Tones and noises may be isolated in our experience, and it is therefore necessary to distinguish between these two kinds of sounds. The sound of shuffling steps and of escaping steam is a pure noise; the sound of an open organ pipe is a pure tone.

83. Properties.—The principal properties of sounds are duration, intensity, pitch, and timbre (tone color).

(1) *Intensity.*—The intensity of a sound is due to the amplitude of the vibrations. As the sound of a tuning fork decreases in intensity, the extent of its vibrations decreases.

When sound waves are equal in amplitude, but differ in length, the shorter wave causes the more intense auditory sensation within certain limits of sound. A simple proof of this fact lies in the common observation of the greater carrying power and penetration of the higher notes of an orchestra or choir. This is true of sounds produced by vibrations ranging from about 800 to 5,000 per second. As the characteristic tones of the human voice fall within this range, nature has thus given to it greater carrying power and penetration than to other sounds outside this range that may be heard together with it.

The absolute sensibility of the human ear for intensity of sound is very great within this region of greatest sensibility. Experiment has shown that, when two just audible vibrations of a body vibrating

at the rate of 3,200 vibrations per second reach the ear in conditions of perfect quiet, the energy applied to the tympanic membrane is equal to that required to raise a weight of one two-hundredth of a milligram one-millionth of a millimeter. The threshold of discrimination for the intensity of sounds, on the contrary, is relatively large, for in the region of greatest sensibility the intensity of the objective stimulus must be increased by at least one-eighth of the amplitude of the original vibration in order to become just noticeable.

84. (2) *Pitch.*—Pitch is the property of sounds due to the length of the vibrations heard. If the pitch of musical sounds is compared with the properties of visual sensations, the differences in pitch may be said to resemble the differences of the black and white series, not those of the various colors.

An interval is the difference in pitch between two tones. Intervals can be indefinitely varied, but not all variations are perceptible, nor are all perceptible intervals used in music.

Noises also have pitch, as the comparison of the sound of a rifle and of a cannon shows. The principal remaining differences between noises are due to their duration. If a noise of brief duration is isolated, it is perceived as a crack, clap, or snap; but if the noise continues, it is perceived as a roar, rumble, rush, screech, hiss, or crash. Most of the noises perceived in our everyday experience are successions of sounds of brief duration.

The average stimulus-scope of tones ranges from about 20 to 40,000 vibrations per second in youth, if the vibrations possess sufficient amplitude. This

is equal to about eleven octaves, of which only about seven are used in music. The seven octaves of a piano utilize sound waves ranging from about 30 to 3,600 per second.

85. (3) *Timbre.*—Timbre is the property of sounds that is due to the form of the vibrations producing them. Musical timbre—or tone color, in the terminology of Helmholz—must be distinguished from more general characteristics by which we recognize the tones of instruments (such as the scraping of the violin bow, or the continuous diminution of the tone of a piano). In common parlance, the musical timbre of a tone is expressed when we speak of the "mellow" notes of a flute, the "brassy" sound of a horn, and the "nasal" sound of a clarinet.

The musical timbre of a tone is produced by the number, proportion, and intensity of its overtones. When the overtones are weak, the timbre of the tone is described as "mellow and clear," as in an open organ pipe. When the lower seven to ten overtones are present in a graduated ratio of intensity, a "bright and brilliant" tone results, as in the human voice or a violin. When the higher overtones, especially the uneven members of the series, are relatively intense, the tone becomes "blaring and strident," as in a trumpet.

The fundamental tone of a musical sound is usually by far the stronger, but in favorable conditions the overtones can be distinctly perceived, though they usually coalesce into a unitary sensation with the fundamental tone. Hence, the ear possesses an apparatus that separates a complex sound wave into its components. The different stimulations thus

produced enable us to hear overtones distinctly from one another. The ear is capable of this analysis even when the tone reaching it is the sound of a full orchestra with chorus, in which the most varied sounds are combined, reflected, and crossed many times before reaching the organ.

86. Vowel Quality.—Musical sounds possess vowel quality (of the continental vowel sounds), going up from *u* at about 250 vibrations, through *o*, *a*, and *e*, to *i* in intervals of about an octave. Above this range the quality changes to *s*, and below the *u* it becomes a vocalized *m*. Transition shades between the vowels have also been observed. Some of the vowels are obtained only by adding overtones of appropriate strength to the fundamental tone. This suggests the view that all pronounced vowel quality is due to overtones.

87. Fusion.—Fusion is a psychic process by which we perceive two or more tones as a unit. The simplest case of fusion is the perception of the fundamental tone with its overtones as a unit. Chords are unitary perceptions of different tones, but this perception is not a parallel to the former example, because the intervals of the chord are smaller, and the tones of about equal intensity. The most striking case of fusion is that of a given tone with its octave, which may in favorable circumstances coalesce so intimately that even a trained ear is not able to distinguish them like other tones.

88. Localization of Sound.—The direction from which a sound proceeds is determined principally by the intensity with which it strikes either the left or the right ear. Generally speaking, sound coming from the right is perceived more intensely in

the right ear than in the left. But, according to Rayleigh's experiments, the difference in intensity is so slight in the case of low sounds that it is not sufficient to account for its localization. Rayleigh accounts for localization in this condition by the phase difference with which a sound strikes the ear on the side from which it comes, and the opposite ear, to which the sound is conducted not only by the air, but also through the bones of the head. Timbre difference is also partly responsible for the localization of sound, for the sound-shadow of the head affects the overtones passing around or through it in the higher regions of sound, and the auricle itself modifies them according to the direction from which the sound reaches the ear.

We estimate the distance of sound by its intensity, timbre, and our past experience. Knowing the intensity of a given sound when it is produced near the ear, we judge it to come from a distance when its intensity is diminished. The lower overtones predominate in near sounds, the higher ones in distant sounds. When this fact is once established by experience, and these qualities of the sound in question are recognized, we judge the distance of the sound accordingly. The predominance of the higher overtones in a given sound may also produce the illusion of relative distance when the sound is really near to us.

89. **Theory of Auditory Sensations.**—The earliest and in general most satisfactory theory of auditory sensation was proposed by Helmholz. He proceeded from the fact that we are capable of perceiving a complex vibration stimulus as a group of simple partial tones. From this he inferred that there are

elements in the ear that vibrate in harmony with the air waves and are separately actuated by them, thus transferring the vibration of every component of the sound waves to different nerve fibers. The basilar membrane fulfills these requirements of an intermediary between the sound waves and the auditory nerve. It increases in width toward the top of the cochlea and contains a very large number of radiating fibers, innervated by the cochlear branch of the acoustic nerve. Each fiber of the basilar membrane is, according to Helmholz's hypothesis, a resonator for a given frequency of sound waves. When the frequency of the sound wave differs but very slightly from that to which the fiber is attuned, the latter is still capable of being actuated by the sound wave. Yet, in this case its vibrations are smaller and fainter, and gradually decrease in intensity until they cease completely when the sound wave differs about half a tone from the pitch to which the fiber is attuned. The basilar fiber transmits the stimulus to the nerve that innervates it, and the psychic reaction that ultimately results from this distinct stimulus of the separate nerve fibers is in each case a different auditory sensation. The latter varies in intensity according to the strength of the stimulus, which in its turn is determined, not only by the amplitude of the sound wave, but also by the perfect or slightly diverging correspondence between the frequency of the basilar fiber and that of the sound wave.

On the basis of this general hypothesis, beats are explained as resulting from the interference of the excitations of two contiguous parts of the basilar membrane by reason of their capacity of being

actuated by stimuli that vary slightly from their proper frequency. These two sections of the basilar membrane are the carriers of the beat. The fibers actuated by the primary tones are so differently attuned that they are not stimulated by the variations effecting the beat.

Various difficulties have been felt to exist in Helmholz's theory of auditory sensations. It is difficult to understand how the 24,000 fibers of the basilar membrane, varying in length from 0.04 to 0.49 mm., are attuned to vibrations varying from 12 or 15 to 20,000 per second. Furthermore, these fibers do not appear to be free to vibrate along their whole length, because they carry the organ of Corti and a blood vein. Moreover, if one tone excites several neighboring fibers, each should produce a different auditory sensation. Nor does the theory account for the production of differential tones when the primary tones are weak. In consequence of these and other difficulties, the theory of Helmholz has been expanded and modified, and new theories of auditory sensation have been received with more or less favor. As they encounter equal and perhaps greater difficulties, Helmholz's theory seems to offer the best possibilities for the complete solution of auditory sensation, which for the present remains a desideratum.

§ 3. OLFACTORY SENSATIONS

90. The Sense of Smell.—The sense of smell has not the importance for man that it has for animals. In the latter, both the organ and the sensations of smell are so highly developed that the corresponding

organs and sensations in man are in comparison with them merely rudimentary structures and activities. Animals distinguish useful and harmful plants by their smell, and they possess an extremely acute perception of animal exhalations, which enables them to follow the scent of their prey.

Savage races possess a much more highly developed sense of smell than civilized man. This condition is largely due to practice and the preferential use of this sense. The sense of smell can be highly trained in man. Pharmacists recognize the nature and properties of drugs, physicians diagnose certain diseases, oil and wine merchants know the qualities of their stock, and blind persons occasionally distinguish their acquaintances by the sense of smell.

91. Organs and Nerves.—In man the olfactory region is located at the upper end of the nasal fossæ, which are of a yellow color, and in which the olfactory nerve is distributed. The peripheral end of the olfactory cells is a straight, elongated process, which terminates in one or more short, thread-like projections, called olfactory hairs. Each mitral cell of the brain is connected with several olfactory cells and many olfactory cells are connected through the collaterals of their axons with several mitral cells.

92. Classification.—Olfactory sensations are manifold. Many substances and living beings have specific odors. In everyday life, taste is often confused with what is really smell. The discovery of new substances and the formation of new chemical compounds (such as chloroform) constantly increases the number of odors. Hence, it is prac-

tically impossible to make an exhaustive list of odors. The difficulty of classifying the sensations of smell is increased by the fact that the olfactory sense of man is imperfect. Many odors have concomitant effects (as in the case of pepper, mustard, and all pungent substances), and they are sometimes popularly classified according to these concomitants rather than their own nature.[1]

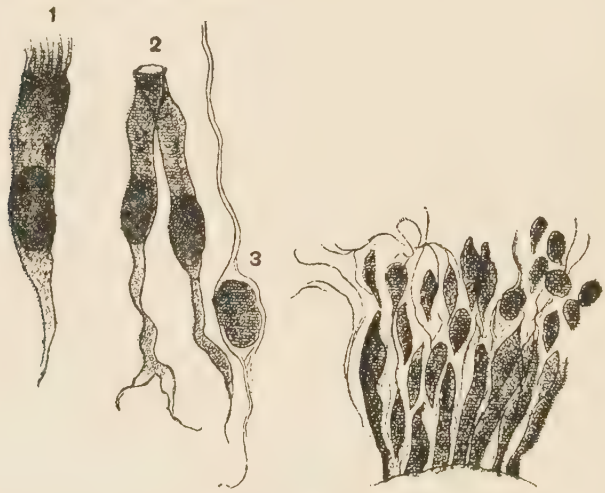

FIG. 10. CELLS OF THE OLFACTORY REGION.

1, an olfactory cell. The peripheral process is surmounted by olfactory hairs. The cell body is long and slender, the nucleus large and clear. The deeper processes form synapses with the mitral cells. 2, sustentacular cells with 3, an olfactory cell adjacent. The figure at the right shows the arrangement of cells in the olfactory bulb.

93. Stimulus.—Odoriferous substances in gaseous form are the adequate stimulus of the olfactory

[1] The following classification of odors, which has been widely adopted despite its limitations, will be useful for purposes of study: (1) ethereal, *e.g.*, fruit ethers; (2) aromatic, *e.g.*, lemon, camphor; (3) balsamic, *e.g.*, vanilla; (4) amber-musk, *e.g.*, amber, musk; (5) allyl-cacodyl, *e.g.*, fish, onions, garlic; (6) burning, *e.g.*, creosol, phenol, tobacco smoke; (7) caprylic, *e.g.*, cheese, sweat; (8) repulsive, *e.g.*, bugs, narcotics; (9) nauseating, *e.g.*, putrefying bodies.

sense, but the manner in which they stimulate the olfactory hairs is unknown. The sensation is produced only by direct contact of the substance with the hairs. Stimulation by direct contact of fluids appears to be an inadequate stimulus, but normal stimulus by odoriferous substances is possible by means of gases contained in the bubbles of the fluids.

94. Threshold.—Olfactory acuity varies much for different odors. The lowest stimulus threshold was obtained by Fischer and Penzoldt for mercaptan, which still produces a faint but distinct odor when diffused in the proportion of 1/23,000,000,000 milligram per cubic centimeter of air.[2] The low threshold of an odoriferous substance does not imply its capacity to produce very intense sensations if applied in large quantities. The odor of violets, vanilla, and tea remains weak, no matter how great the objective stimulus.

95. Mixtures.—Simultaneous perception of several odors may produce opposite effects. (1) New and composite odors may result, as is the case in cologne and the odor of restaurants and drug stores. Adaptation of the organ, however, often causes one of the component odors to predominate. (2) Compensation of odors results. Two odors may neutralize each other, or one may completely or partly neutralize the other. Thus, perfumes may disguise objectionable odors. The odor of rubber is neutralized by that of wax; the odor of castor oil, by oil of cloves.

96. Adaptation.—The sense of smell is easily fatigued. When an odor acts on the olfactory epithelium with the same intensity for even a short

[2] Ebbinghaus, *Grundzüge der Psychologie,* I (1911), 424.

time, the sensation that it produces gradually decreases and finally disappears. But this temporary fatigue, which renders the organ incapable of perceiving a given odor, disappears when the odor is varied in intensity or entirely removed for a short time. Adaptation to the odor renders the organ insensible, diminishes its sensibility, or leaves it unimpaired for the perception of other odors.

97. **Pathology.**—Changes in olfactory sensation are effected, not only by mixtures, adaptation, and compensation, but also by pathological conditions. Influenza may destroy or diminish the sensibility of the olfactory organ for vanilla, musk, and fruit odors, but leave it unimpaired for others. It may also cause a perversion of its sensibility, so that the odor of tobacco seems identical with that of coffee.

§ 4. GUSTATORY SENSATIONS

98. **Organ.**—The taste-buds, located principally on the back, sides, and tip of the tongue, are the organs of taste. Taste-buds are also found on the anterior surface of the soft palate and the posterior surface of the epiglottis. They are distributed in three kinds of papillæ situated in various parts of the taste areas. The taste-buds are so imbedded in the mucous membrane that their apex is immediately behind an epithelial pore, and communicates freely with fluids that come into contact with the tongue.

99. **Taste and other Sensations.**—The sensations that in practical life are usually described as taste, are in reality associations or combinations of several different classes of sensations. The taste of

food is associated with its odor, which we perceive during expiration in eating, with cutaneous sensations of hardness, softness, temperature, and astringence produced by the contact of the mouth with food, and with organic sensations of the digestive organs. Only the residue that remains, after deducing all these concomitants, constitutes the true sensations of taste.

100. Classification.—Sweet, sour, salt, and bitter

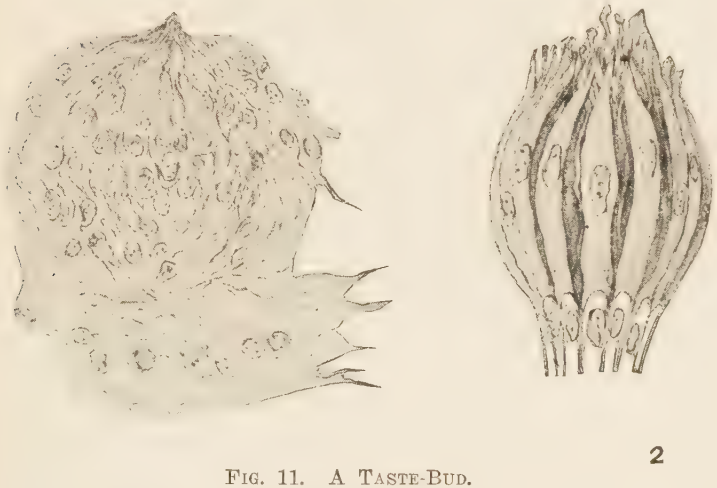

FIG. 11. A TASTE-BUD.

1, vertical section. 2, lateral view. The gustatory hairs project at the top of the bud. Sustentacular cells form an envelope around the gustatory cells and also lie between them in the bud.

are the four fundamentally different sensations of taste. When these sensations are simultaneous, it may require attention and practice to enable one to distinguish them—*e.g.*, the taste of a peach may be analyzed into sweet, acid, and bitter. A trained taste finds that most substances capable of exciting the gustatory sense produce a combination of the

fundamental sensations of taste in different degrees of intensity.

101. Localization of Function.—Not all papillæ possess the capacity of perceiving all the four fundamental qualities of taste. Some taste-buds—or parts of them—are excitable either by one or by several qualities, and the capacity for perceiving these qualities is not equally distributed over the entire organ. The maximum sensibility to sweet is at the tip of the tongue, the minimum at its base. The greatest sensibility to bitter is in the circumvallate papillæ, the least at the tip of the tongue. The greatest sensibility to acid is in the middle of the border, and decreases from there in all directions. The maximum sensibility to salt is at the borders and the tip, the minimum at the base.

102. Stimulus-Threshold.—In this, as in other senses, the keenness of perception varies in different persons. Bitter has the lowest threshold. Kiesow's experiments on the sensibility of the tip of the tongue yielded the following average of results for the stimulus-threshold: sugar, 0.5%; salt, 0.25%; hydrochloric acid, 0.01%; quinine sulfate, 0.0003%.

103. Compensation and Contrast.—The sweetening and salting of food and the flavoring of medicine are familiar examples of the reciprocal influence of tastes. While the effects obtained in this way largely consist in the substitution and mixture of the fundamental qualities of taste, the combination of these qualities also produces alterations of the sensation. For example, a mixture of sweet and salt diminishes the sensation of each, but a very diluted mixture of sweet and salt destroys these

sensations and results in an insipid and alkaline sensation.

§ 5. CUTANEOUS SENSATIONS

104. A Complex Sense.—The skin is not, as it is popularly described, the organ of "feeling," though this use of the term is unquestionably justified both by long usage and by undoubted convenience. But, on the one hand, the term "feeling" also has a specific meaning, which expresses a psychic state not produced by sense stimulus, and, on the other hand, the skin possesses not one but four different senses. These cannot be described satisfactorily by a single term, because they differ from one another as much as sight differs from hearing.

The skin is not a true organ of sensation (like the eye or the ear), for it has not the special structure of an organ, and it is not affected by a special stimulus, like a true sense. The skin is rather the tissue in which several important senses, possessing distinct organs, are imbedded.

105. The Skin.—The skin consists of two parts, the *epidermis* and the *cutis*. The *epidermis* is composed of an outer layer of epithelium (which is not sensitive, and is hence termed also the horny layer), and of an inner, softer part, named the Malpighian layer after its discoverer. The Malpighian layer contains the pigmentation of the skin and is closely moulded on the adjoining surface of the cutis. Below the epidermis lies the *cutis* or true skin, a sentient, vascular, fibrous membrane in which the papillary and the reticular layer may be distinguished.

106. Organs.—The principal nerve-endings that serve as sense organs in the skin are free nerve-endings and touch-disks in the Malpighian layer, Golgi's and Mazzoni's corpuscles throughout the cutis, Meissner's corpuscles in the papillary layer, and Pacini's corpuscles in the adipose layer. The sensory functions of these bodies have not yet been established with certainty. The free endings of the nerve plexus in the outer sheath of the hair roots, the touch-disks, and in places devoid of hair Meissner's corpuscles appear to be the organs for the appreciation of pressure. The free endings of the superficial nerve plexus in the Malpighian layer probably are the pain spots. Heat is probably perceived through Pacini's corpuscles, and cold probably through those of Golgi and Mazzoni.

107. Classification of Sensations.—Popular nomenclature for the sensations of the skin is rich and varied, but all may be reduced to three or four kinds. In 1882 Blix discovered the heat, cold, and pressure spots, and some years later von Frey discovered the pain spots. The sensations of temperature, pressure, and pain are irreducible, and therefore constitute different classes of sensations. Itching and tickling are regarded by some investigators as distinct classes of sensations, but others refer them to weak pain and pressure stimuli respectively. The sensations of temperature, pressure, and pain are not only irreducible psychic experiences, but are independently variable. Sensibility to pain completely disappears in the early stages of anesthetization, while sensibility to pressure and touch still remains unimpaired. Certain diseases of the spine

appreciably dull the sensibility to temperature and pressure.

108. Sensations of Temperature.—The existence of warm and cold spots is established by applying the respective stimuli (such as the point of a pencil or a uniformly heated, blunted needle) to various points of the skin. The cold spots are easily found, the warm spots are more difficult to determine. In both cases the sensation is not punctate, but extended.

The cold and warm spots react to mechanical and electrical, as well as to their normal stimuli. Besides their normal reactions, the cold spots also possess the reaction usually called Frey's paradoxical sensation of cold. When a cold spot is stimulated by an excitant heated to 45 or more degrees Centigrade, it reacts with a sensation of cold.

The intensity of cold and warmth depends primarily on the intensity of the stimulus and the density and sensibility of the temperature spots in the stimulated area, but it also increases when an extended area is stimulated. The sensation of warmth is notably greater when the entire hand or the arm is immersed in hot water, than it is if only one finger is immersed in it.

The parts of the body that are usually covered are more sensitive to cold than the parts usually exposed. This is due partly to habit and partly to the greater number of cold spots on the parts usually covered.

The reaction times for cold and pressure are shorter than those for heat and pain. Hence, if hot and cold stimuli are applied to the same region

simultaneously, the latter produce their corresponding sensation sooner than the former. The sensation of cold also reaches its culmination quicker than that of heat. This may be due to the fact that the organs for the appreciation of heat lie more deeply in the skin than those for the perception of cold.

The power of discriminating warm and cold spots differs. Cold spots can be plainly and accurately localized when they are from 0.8 to three mm. apart, but in the same region heat spots can be accurately discriminated only when they are from two to five mm. distant from one another.

The stimulus-scope for sensations of heat and cold varies from 70 to —10 degrees Centigrade, both for external and internal stimuli (fever, fear, shame). When the stimulus lies beyond these limits, it produces sensations of pain, but not of heat and cold. Within the stimulus-scope lies the indifferent temperature, or physiological zero point, which is the temperature that produces no thermal sensation. It is not a definite point on the scale of the thermometer, but varies between about 31 and 35 degrees Centigrade in different regions of the body and in different conditions of the same region. If we are in a room heated to normal temperature, we have no thermal sensation; but if we come into the same room from the cold outdoor atmosphere, we experience a sensation of warmth.

In favorable conditions, the threshold of discrimination for sensations of temperature is as low as one-tenth or even one-twentieth of a degree Centigrade. Near the stimulus-threshold and the measure of receptivity, considerable differences in tem-

perature are barely distinguishable, and punctate stimuli are less distinguishable than extended stimuli within the same stimulus-scope.

There are two chief theories of thermal sensation. According to Weber, we perceive only the rise and fall of the temperature of the skin. Its rise is felt as heat, its fall as cold. This theory affords a good explanation of adaptation, but it fails to explain why adaptation is restrained within certain limits, and why a sensation of cold continues to be felt after the stimulus has been removed, and the area is becoming warm.

According to Hering, the thermal stimulus produces a process of dissimilation and assimilation in the organs of the thermal sense. The former process is perceived as heat, the latter as cold. When both are simultaneous and equal, they neutralize each other and the physiological zero point results. This theory does not agree with the proved fact that there are distinct heat and cold spots. A satisfactory theory of thermal sensation has yet to be found.

109. Sensations of Pressure.—In those parts of the body that are clad with hair, there is a pressure spot at the point where the hair emerges, on the side from which the hair follicle slopes. A lesser number of pressure spots are found between the hairs. Very numerous touch spots are found on hairless regions, such as the palm of the hand, the finger-tips, the tip of the tongue, and the red part of the lips. The average number of pressure points on the human body is about twenty-five per sq. cm. On the finger-tips and the skin of the head there are over one hundred per sq. cm.

The distribution of touch spots per sq. cm. is, on the average, one on the middle anterior surface of the leg, two on the upper part of the flexor surface of the left arm, over three on the middle of the back, and over four on the radial surface of the left wrist.

The average sensitivity of the touch spots is lowest on the middle of the back, twice as great on the middle anterior surface of the left leg, three times as great on the middle of the flexor surface of the left arm, about three and a half times as great on the radial surface of the left wrist, more than seven times as great on the left upper eyelid, and slightly greater on the glabella of the forehead. The most sensitive parts of all are the tip of the tongue and the middle part of the edge of the lower lip. The tip of the tongue is about twenty times as sensitive as the finger-tips of the left hand, the lower lip somewhat less. It is a very delicate and difficult matter to determine the stimulus-threshold for tactile sensitivity by the methods at present available.

110. Sensations of Pain.—Pain is a specific sensation whose essential character can be known only as it appears in consciousness. Pain is not excessive heat, for a burn is never felt as excessive heat. In certain injuries to the spine, dissociated paralysis of sensibility to pain occurs, while the other qualities of cutaneous sensibility remain unimpaired. These facts prove that pain is a specific sensation.

Pain spots are difficult to demonstrate, because any part of the skin experiences a sensation of pain when subjected to strong pressure. The cornea contains many pain spots, but no true pressure spots. The conjunctiva of the eye and the glands are rich in cold and pain spots. The mucous mem-

brane of the cheeks and the rear part of the cavity of the mouth and of the tongue have little sensitivity to pain.

Sensitivity to pain varies, not only with the number of pain spots, but also with the thickness of the epidermis. The lips and the temples react with a sensation of pain to stimuli that are not effective on the back of the hand. The cornea is the part most sensitive to pain. Its middle area is sensitive to the stimulus of fine hairs, but reacts only with a sensation of pain, while its edge is also sensitive to cold.

Strong pressure, extreme temperature, and chemical and electrical excitation are the pain stimuli. Among the chemical stimuli are certain acids and the fluids contained in the pricks of plants and the stings of insects. An electrical stimulus that is too weak to produce a sensation of pressure may cause a sensation of pain.

The reaction time for pain stimulus is longer than that for touch, and the after-sensation is much longer. If the stimulus is short and intense, the sensation of pain does not result until after the stimulus has been removed. The pain of a wound may not be felt until some time after it has been inflicted. If a large area is stimulated, the reaction to touch is a thousand times greater than that to pain; but, as the area stimulated is diminished, the liminal value of pain stimulus increases until it may be greater than that of touch. When a single intense mechanical or thermal pain stimulus is suddenly applied, the reaction may consist in two succeeding sensations of pain at an interval of about one second. In this case there is a very long latent or

reaction period, which may amount to 0.9 second. Sensations of pain may also be produced by mechanical and thermal stimuli that are too weak to cause a direct excitation of the nerve fibers, because these fibers do not possess so long a latent period of excitation. In general, the stimulus-threshold for sensations of pain is high, a pressure of 20 to 50 grams per sq. mm. being required.

§ 6. KINESTHETIC AND ORGANIC SENSATIONS

111. Motor Sensations.—Motor sensations are internal sensations by which we are aware of the movements of the members of the body. Our experience of their motion is composed of several factors. The eye sees the movement; the muscles and tendons have a sensation of tension, relaxation, and fatigue; and the skin has a sensation of pressure and tension. But these factors appear to be only concomitants of the internal sensation of movement, which is of articular origin.

The articular origin of the internal sensation of movement is asserted chiefly for two reasons:

(1) the testimony of consciousness that the movement of the members produces in the joints the sensation of two smooth surfaces moving upon each other. The enclosing membranes of the joints have many nerves on which Pacini's corpuscles are distributed. and the bones themselves possess many nerves. Pacini's corpuscles transmit the sensations of traction and pressure. When the joints move, the process of friction, traction, and pressure that normally takes place, must stimulate these nerves;

(2) faradic stimulation of the joints raises the

stimulus-threshold appreciably. If the finger is in normal condition, the movement of the first interphalangeal joint is just perceptible when it is moved through an angle of 0.5 degree; but, if a faradic current is introduced into the joint, the threshold is raised to an interval that varies from 1.5 to 3.85 degrees, according to the strength of the current. In the absence of the current, the finger experiences a sensation of weight when lifting 8 grams; faradization of the joint makes a weight of 75 grams necessary to produce the sensation.

112. Static Sensations.—The vestibular branch of the acoustic nerve enters the ear in five places, namely, at the ampullæ of the semicircular canals and at the saccule and the utricle, which contains the otoliths. When the head moves in any direction, a pressure of the endolymph and the otoliths is exerted in the opposite direction. This undoubtedly gives rise to many complex stimulations of the vestibular branch of the acoustic nerve.

Since this branch of the acoustic nerve does not serve the purposes of hearing, it has been suggested that it is the organ of sensations of position and movement of the head, and indirectly of the entire body. On this supposition, giddiness is explained as arising from conflicting sensations of movement and position, when it is not due to optical illusions of movement and to other external causes of similar nature.

This theory is based on the following facts. Section of the semicircular canals in animals invariably induces loss of equilibrium, of the awareness of position, and of the power of controlling the movements of the body, primarily of the head. If particles of

iron are inserted into the vestibule of the ear of a species of crabs that regularly lose and renew their otoliths when they cast their skin, the attraction of the particles by a magnet makes them turn in the opposite direction, just as a human being turns to recover his equilibrium by a rapid turning motion after the impact of the endolymph and the otoliths. Moreover, many deaf-mutes that are not subject to giddiness have been found after death to have had defective semicircular canals. Finally, certain diseases of the labyrinth cause giddiness, which can also be induced by a galvanic current passed through the ear.

Static sensations are probably sensations of pressure that give rise to reflex movements. Some investigators, however, consider them as specific sensations.

113. Organic Sensations.—Organic sensations take place in the internal organs, especially in those that serve the vegetal functions of the organism. They make known to us the condition of the organism, particularly disturbances of its vegetal functions. Organic sensations are usually imperfectly localized and vague in quality, but they are of great importance for one's physical well-being; for, if they are impaired or lost, the same fate befalls the sensation of physical well-being, the perception of the vegetative needs of the body, the emotional life, and the normal perception of the succession of time.

Organic tone and dull or acute pain are the fundamental classes of organic sensations. Pain is nature's danger signal attracting attention to a disturbed condition, and diverting it from the higher work of life to the elementary needs of human exist-

ence. When the organism is in normal condition, nature does not attract our attention to it, in order that we may be free to devote ourselves to rational ends.

Organic sensations of pain are often designated by the organ in which they are present (*e.g.,* headache and stomachache). Temporal and spatial relations are indicated by such terms as tearing, throbbing, and burning pain. Among the other characteristic sensations are especially hunger and thirst in the organs of nutrition, comfort and discomfort in the entire organism, fatigue and freshness in the organs of movement, oppression and apprehension in the circulatory system, depression and stifling in the respiratory organs.

The background of our psychic life is formed by numerous pairs of organic sensations, such as excitement and calm, freshness and fatigue, brightness and dullness, power and lassitude.

Fatigue is physical or mental, although these two classes are not altogether separable. Physical fatigue manifests itself in deep and rapid breathing, quick pulse, and high temperature. The amount and quality of work decreases, the mind becomes slow and dull, and pain and complete exhaustion follow. Mental fatigue at first impairs the quantity and quality of work, and makes attention unstable. Sense perception, memory, and imagination are next affected. Most of the signs of physical fatigue appear. Aversion to work, exhaustion, desire for rest, and finally sleep complete the process of fatigue.

Physical fatigue in one part of the body affects the other parts, and indirectly induces mental fatigue, because the toxins that fatigue produces in

the muscles are spread through the body by the blood. Both physical and mental fatigue consume the tissues.

Collateral Reading.—Mercier, *Manual of Modern Scholastic Philosophy,* Vol. I, pp. 191–208 (The External Senses); Watson, *Psychology from the Standpoint of a Behaviorist,* Chapter III (The Receptors and their Stimuli); Warren, *Human Psychology,* Chapters IX-X (The Senses); Ladd and Woodworth, *Elements of Physiological Psychology,* Part I, Chapter VIII (End-Organs of the Nervous System); *ibid.*, Part II, Chapters I–III (The Quality and Quantity of Sensation).

Seashore, *Elementary Experiments in Psychology,* Chapters I–III and VII; Snow, *Problems in Psychology,* Chapter V.

CHAPTER VI

SENSE PERCEPTION

§ 1. SENSE PERCEPTION IN GENERAL

114. Origin.—Sense perception is the sensory cognition of the time and space properties of objects. It is not identical with sensation, because it is not the immediate and direct effect of the sense stimulus, and lacks quality and intensity, which are essential properties of sensation. The perception of the third dimension of space is not a sensation, because it is not directly caused by the sense stimulus; but it is an act of sense cognition, not a logical abstraction, because it is a psychophysiological process in the entourage of sensation.

The chief psychic acts that give rise to sensory perceptions are:

(1) the assimilation of sensations through their involuntary completion by memory. In this process the full cognitional reaction to peripheral excitation is facilitated and accelerated by means of recalled sensations, perceptions, and concepts. Assimilation is caused by the coöperation of central and peripheral excitation with memory dispositions. In reading, the eye does not perceive all the letters of the words, whence misreadings and oversights take their origin. A fugitive glimpse of a person on the street is completed into the figure of a friend;

(2) the unifying tendency of attention and of sense consciousness, which effects the more or less intimate fusion of different and unrelated simultaneous sensations into a single content of consciousness. A group of tones are perceived as a chord. Two or more odors may be perceived as a unit (*e.g.*, a perfume). A post and a heap of ground may appear as an animal when seen in the distance;

(3) spontaneous interpretation, which in the light of past experience may add new and unrelated elements to sensations and concepts. A cry and the sound of a fall brings up the vision of an accident. Perspective is interpreted into pictures.

Besides its tendency to unification, sense consciousness possesses two opposite tendencies of great importance: the trend toward persistence and that toward change. The indispensability of the accustomed and the loss of impressionability are further instances of the teleological arrangement of the faculties of man. The former gives him the constancy and steadfastness required for thoroughness in his work, and the latter leads him to vary his activities in such a manner as to bring about the harmonious development of his personality and to fulfill his manifold duties.

§ 2. THE PERCEPTION OF SPACE

115. Object.—Our principal spatial perceptions are those of the extension, size, shape, distance, and direction of objects. The distance and direction of objects are perceived relatively to ourselves and to other objects. The distance of objects may vary indefinitely, but all directions are reducible to the

three fundamental dimensions of height, breadth, and depth.

116. Organs.—The sense of vision and the cutaneous and kinesthetic senses are the means with which nature has endowed man for the direct perception of space. Hearing, smell, and taste are completely devoid of the characteristic spatial perceptions of the extension, size, and shape of objects; but these senses are capable of indirectly localizing their objects by referring them to the objects of sight and touch.

The ability to approach objects, to go around them, to see and touch them from every angle, and to move the eyes even when the head is in a stationary position, are of the greatest importance for the formation of spatial perceptions. The sense of touch and the motion of the eyes trace the outlines, measure the distance, and follow the movement of the objects perceived. Binocular vision is particularly valuable for the perception of the perspective plane. Even in the absence of vision, cutaneous and kinesthetic sensations make known to us the spatial properties of objects.

Under the influence of experience, impressions of these properties which were acquired through various senses and in different ways are gradually associated, and ultimately fused into general spatial perceptions. Once they are associated, the different spatial perceptions combine to yield the complete percept of the spatial properties of individual objects.

117. The Cutaneous Senses.—The accurate spatial perceptions of persons afflicted with congenital blindness are evidence of the formation of these

perceptions by means of cutaneous and kinesthetic sensations. But few persons endowed with normal vision form their spatial perceptions by means of this sense, because they commonly make use of visual representations to determine the position of sensations of touch.

The perception of the extension of objects and, subordinated to it, the perception of their size and shape are the fundamental spatial perceptions of the cutaneous senses. There can be no doubt as to the origin of these perceptions through these senses, since we are able to perceive these properties (*e.g.*, in the case of a book) even in total darkness. But the perception of the shape of objects and the discrimination of sizes by means of the sense of touch is considerably inferior to the perception of these properties through the sense of vision. The perception of spatial properties through the sense of touch is improved by successively touching different parts of the object and by concentrated attention.

Localization is the determination of the place where the skin is touched. One may be able to discriminate two sensations without being able to localize them accurately. Hence, localization is a special function of spatial perception. The determination of the relative positions of two sensations is a further function of spatial perception, which must likewise be carefully distinguished from the mere discrimination of sensations.

The sense of touch acquires a keen perception of the continuity of a surface, of areas standing out in relief on it, and of separation and contact between adjacent surfaces. Contact and separation, direction and distance, and reliefs are easily perceived

on a row of coins. Braille type—a system of printing for the blind, in which points raised above the surface of the paper are used as symbols of letters and figures—is the most important application of this function of spatial perception.

The tactile perception of the form of the body and the distinction of the positions and forms of its members result from special kinesthetic experiences, and are of fundamental importance for the distinction of spatial properties localized on various parts of the body from the same properties perceived in other objects. When the foot touches the floor, we can distinguish our perception of the foot's extension from the perception of the extension of the floor.

118. The Eye.—Since the retinal area of most acute vision is very small (Section 70), each eye is equipped with three pairs of muscles, by means of which it can be turned in its socket, so that the object to be fixated in the field of vision is imaged on the yellow spot. By turning the head, these movements of the eyeball are reduced, the strain on the ocular muscles is lessened, and the field of vision enlarged. Binocular vision has the advantage of increasing the field of vision while the head is stationary, of allowing a more perfect inspection of space by looking at an object from two fixed points, of facilitating the determination of the distance and the real size of objects and making it more accurate, and of correcting congenital or acquired defects of one eye by means of the other. The spatial perceptions of the eye are obtained by distinguishing the shape and size, the color and brightness, and the position of objects.

§ 3. PSYCHOLOGICAL PROBLEMS OF SPACE PERCEPTION

119. Space.—A definite concept of space, and of the various senses in which this term is used, is a prerequisite for understanding the problems of space perception. When bodies are said to be in space, this term designates extension in three dimensions, distinct from these bodies and occupied by them. But real space is not itself a body. Geometry studies space considered abstractly as extension in three dimensions. Absolute space is an even more general concept designating unlimited extension capable of being occupied by bodies. In all of these acceptations, space is not a subjective construction of the mind, nor an object existing in itself, but a mental entity founded on the real or possible extension of bodies, and therefore termed in Scholastic philosophy an *ens rationis cum fundamento in re.*

But, quite apart from these concepts perfected by experience and reflection, sense perception also possesses spontaneously given spatial characters. A child opening its eyes for the first time, or an adult looking out on the world for the first time after obtaining sight through an operation, doubtless has an immediate visual perception of objects or their parts as being beside one another or apart from one another. The first tactile experience has the same properties. Further experience teaches the distinction between a flat disk and a sphere, between near and distant objects, between large and small bodies, between continuous and discontinuous surfaces and solids.

120. Visual and Objective Size.—The true spatial

properties of objects are not always immediately and accurately given in our spatial perception of them. At least three phases may be distinguished in the elaboration of these perceptions from the original objective data:

(1) the immediate subjective impression contained in the field of vision does not always accurately represent the spatial properties of objects. A pencil held in the hand is larger in the field of vision than a tower seen in the distance;

(2) subjective interpretation of the visual percept in the field of vision, in the light of past experience, yields an approximately correct perception of the spatial characters perceived. In this way we may estimate the height of the tower seen from afar as 500 feet, by comparing it with the remembered percept of other objects seen from the same distance. In this case the small extension that the tower we now see has in the field of vision is recognized as much greater than that of the pencil;

(3) objective verification yields an approximately correct perception of spatial characters. By measuring the height of the tower with the aid of a quadrant, we may find that it is 555.1 feet. Yet, this mathematical measurement in its turn is no more than a comparison of several perceptions previously verified by analogous measurements.

These simple observations show that our visual perception of spatial properties is bound up in many ways with the spontaneous interpretation of percepts on the basis of assumption, knowledge, and past experience.

The examination of the accompanying figures shows in another way that the spatial content of

visual perception does not necessarily correspond to the spatial properties of the objects seen.

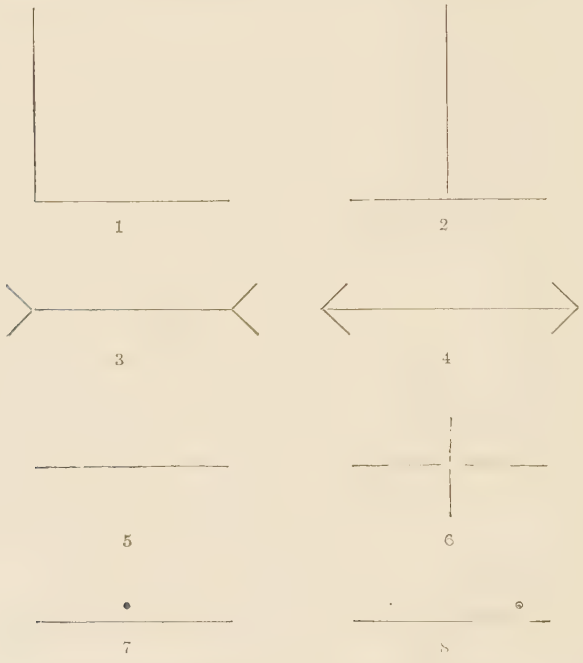

Fig. 12. Geometrical Optical Illusions.

The verticals in 1 and 2 appear to be longer than the horizontals. The horizontal seems longer in 3 than in 4. 5 appears to be longer than 6, and 8 than 7.

121. Problems.—Since the capacity for spatial perception is a native endowment of man, the general fact of the reaction of the sense faculties to this perception is not a psychological problem. But the processes and conditions that give rise to specific spatial perceptions as reactions to definite sense

stimuli are psychic factors and laws to be investigated.

(1) *Localization.* Every object perceived in the field of vision has a definite position that is entirely beyond our control. It is always before the eye, never beside or behind it. If the object is actually on the left or the right of the eye, it is invariably perceived in this position. Which factors and laws determine the localization of the object in the field of vision?

(2) *Depth Perception.* Spatial perceptions have the three dimensions of height, width, and depth. Even if we look out into blank space, into a clear sky, into a dark shaft, or into a dense fog, the perception of depth still remains. We do not perceive a flat surface. What is the foundation of plastic vision?

(3) *Continuity.* We perceive continuous lines and objects of many kinds, and in general we discriminate readily between continuity and discontinuity. The field of vision itself is an unbroken unit. Yet the visual elements of the retina are separated from each other, and their interstices are visionless areas. Why, then, is the field of vision continuous? Why is the blind spot not perceived in ordinary vision?

(4) *Optical Illusions.* Several normal illusions are shown by Figure 12, and many more might be added.[1] In a moving picture the figures do not actually move on the film, but the extremely rapid succession of photographs with the figures in slightly

[1] See Myers, *Textbook of Experimental Psychology*, Vol. I (3rd ed., 1925), pp. 283–92; Ebbinghaus, *Grundzüge der Psychologie*, Vol. II (3rd ed., 1919), pp. 51–121.

different positions produces the impression of movement. These phenomena are not true illusions, but we may reasonably ask which are the factors that produce the deviation of the visual content from the visualized objects?

§ 4. LOCALIZATION

122. Fixation.—Not all parts of the retina have equally perfect sight. Whenever we desire to see an object with the greatest clearness and distinctness, we turn the eye so that the image of the object falls on the yellow spot. Since this part of the retina is most highly susceptible to light, we are able to perceive even minute differences in the visual and perceptional characters of objects seen with it. If we examine a large and intricate mathematical design, such as the ornaments devised by Moorish artists for the embellishment of books and buildings, we have a clear and distinct perception of the smallest details of the interlacing lines, figures, and colors. But beyond this field of most distinct vision we cannot distinguish the same details as long as we continue to center our gaze on that part of the design we originally fixated.

123. Local Sign.—Since the absolute and relative position of the objects perceived in the field of vision and the position of the fixation area in the same field are entirely beyond the control of the subject, we must infer that they are determined by the visual elements of the retina. This function may be termed the local sign of visual perception, but without the implications attached to this designation by Lotze and his followers. The local sign deter-

mines the position of the object with regard to the eye and the relative position of objects toward one another in the field of vision.

It is to be noted, however, that because of anomalies in the position of the rods and cones, the position of the retinal elements stimulated by the object does not always correspond perfectly to the actual position of the details of the object in space.

124. Origin of Spatial Perception.—Spatial distinction of retinal stimulation results in spatial distinction of visual perception, but, since spatial distinction of olfactory and gustatory stimulation does not produce spatial perception in these senses, the origin of spatial perception in the sense of vision is the subject of a special inquiry. The empiric and the nativistic theories are the chief explanations that are advanced to account for the origin of spatial perception.

125. Empiristic Theories.—The empiristic theories ascribe the origin of our perception of space and time to the psychic elaboration of other, more elementary cognitional elements (chiefly sensations), and therefore give them an entirely subjectivistic character.

One group of the empiristic theories regards the soul as predominantly passive in the formation of perceptions. In their view, perceptions are the product of the association of sensations, either according to the general laws of association or according to special laws. Thus, they derive the perception of space from a peculiar combination of visual and tactile with kinesthetic sensations.

Among the reasons adduced by the advocates of these theories, the following may be mentioned:

(1) perceptions are always connected with sensations, but have no external cause of their own. Hence, they result from a combination of sensations;

(2) the general concepts of space and time are the products of association. Hence, elementary sense perceptions originate in the same manner.

Another group of empiristic theories, which are identified with the philosophy of idealism, consider perceptions altogether as products of the mind. Kant maintains that sensations, as received in the faculty of sensibility, are unrelated and devoid of order. They act as a stimulus on the soul, which under this influence forms, relates and connects the data of sensation, and thus elaborates them into perceptions. Hence, sensation is the occasion, but not the cause of perception. The latter is the product of the soul alone.

This group of theories is founded on the following observations: (1) since the same perception results from different sensations, and different perceptions originate from the same sensations, both are independent in the sense that the objects perceived by the senses do not cause perception; (2) sensations are often devoid of perception until attention and will make them appear in consciousness. Hence, again, perceptions originate solely from psychic processes, and not from objective causes.

126. Lotze and Wundt.—Lotze sought to explain the subjective origin of spatial perceptions by means of his theory of local signs. When visual stimuli of a certain strength excite any point of the retina outside the area of direct vision, the eye by a reflex movement turns itself so that the stimuli are transferred from the original point of incidence to the

yellow spot. The extent and direction of this movement is perceived by kinesthetic sensation. Since this reflex occurs at all points of indirect vision, each one of them gradually acquires a local sign, consisting in the perceived extent and direction of the reflex. Each local sign is originally non-spatial, and remains attached to all visual sensations occurring in the corresponding point of the retina. The visual impression and the local sign of each point of the retina stimulate the soul in such a manner as to cause it to localize visual sensations beside one another in space. The perception of the entire field of vision as a unit, even without ocular movement, is caused by the gradual formation of fixed associations between the visual impressions and local signs of each part of the retina. In virtue of these associations, indirect vision, with the eye in a state of rest, produces representations of the local signs that would actually be present in the eye if the objects perceived by indirect vision were seen by direct vision. The many representations of local signs, thus constantly present—but unperceived—in consciousness, cause the same localization of the objects in the field of vision that the actual local signs corresponding to them would cause.

Wundt endeavored to improve Lotze's theory. (1) He postulates a special "local color" in every visual and tactile sensation as the link invariably connecting it with its corresponding kinesthetic sensations. (2) Spatial perception is the fusion (*Verschmelzung*) of tactile and visual sensations, possessing local signs in the sense of Lotze, with the kinesthetic sensations produced by the action of touching and fixating objects. This is Wundt's

principle of creative synthesis, according to which the combination of psychic elements possesses properties entirely lacking in the elements apart from this combination.

127. Critical Note.—The reader is referred to treatises on natural philosophy and criteriology for a detailed study of the objectivity of the representations and concepts of space.[2] The following considerations show the untenability of the purely empiristic theories of spatial perception:

(1) the perception and the concept of space are objective, because their foundation, the extension of bodies, is real;

(2) if there were no objective spatial characters in sensation, it would be impossible for the soul to construct them entirely out of itself, because the soul can form, associate, and relate only what is already given in sensation;

(3) if the soul were able to construct spatial perceptions from visual and tactile sensations, it would by the same token possess the power to construct them from gustatory and olfactory sensations—a feat that is manifestly impossible;

(4) the theories of Lotze and Wundt are undoubtedly ingenious and carefully worked out, but they are as mysterious as the problems they undertake to explain and devoid of any foundation in fact. They are not observed facts, nor necessary deductions from the analysis of facts, nor necessary presuppositions for an explanation of psychic facts. They

2 *E.g.*, Schaf, *Institutiones Cosmologiæ* (1907), pp. 86–116, 202–26; Idem, *Kantii Introductio in Criticam Rationis Puræ* (1911), pp. 131–168; Geyser, *Allgemeine Philosophie des Seins u. der Natur* (1915), pp. 274–305; Coffey, *Epistemology*, Vol. II (1917), pp. 184–207; Nys, *La Notion d'Espace* (1922).

are tentative hypotheses that could be accepted only if they were proved by definite reasons and further substantiated by refuting the counter-arguments of the nativistic theory.

128. Nativistic Theory.—The visual and cutaneous senses have an original spatial perception, which is highly perfected by experience. The spatial distribution of stimuli in these organs is not alone sufficient to account for the spatial character of their perceptions, because, if it were the adequate reason of the perception of space, we should expect to have similar perceptions also by the organ of hearing, in which the stimulus is likewise distributed and received by different fibers of the terminal structures of the acoustic nerve. On the other hand, though spatial perception represents spatial properties of objects, it is no more spatial in itself than sensation as a psychic act is colored, bitter, or pungent, because it represents these properties of objects.

Every visual stimulus has at least a minimal extension, and so contains the foundation of spatial perception, even if it is so small as to affect only a single visual element of the retina. When the stimulus is sufficiently extended to strike several visual elements, as is usually the case, the areas perceived by the individual retinal elements overlap, and thus we have the perception of a continuous surface. There are no blank, or blind areas in the visual field, corresponding to the visionless interstices between the rods and cones, because these parts of the retina have no perception whatever, not even of dark space. When only a part of the retina is stimulated by light rays, the true position and proportion of the object

perceived are preserved by subjective stimulation of the remaining parts of the retina, the so-called intrinsic light effected by the circulation of the blood, temperature, etc.

§ 5. DEPTH PERCEPTION

129. The Problem.—The problem of depth perception is the principal matter of controversy between the nativistic and the empiristic theories of space perception. It is an evident fact that we have not only a knowledge of the third dimension, but also a corresponding sense perception.

The eye distinguishes without difficulty between good and poor perspective in pictures, and between the perspective of a photograph and that of the landscape it represents. Hence the eye has a true perception of spatial depth. Whence does it arise? Is it an original innate character of visual perception, or does it result from experience?

130. Binocular Vision.—Although the separate eye movements of the blind show that ocular movements are not necessarily coördinated, a natural reflex turns both eyes toward the object seen. Thus, the two eyes constitute a single instrument of vision, fusing the two images of the object into one. The fundamental action underlying single vision by means of both eyes is the adaptation of their position so that the visual axes intersect at the fixation point.

Single vision is attained only when the fixation point lies within the field of binocular vision. It is accomplished by the partial superposition of the two uniocular visual fields. Outside the superposed fields, we have only uniocular vision, extending on

each side about one half of the distance from the center to the margin of the binocular field in the retina.

Two of the coördinating reflexes of the eyes require mention. (1) When the eyes are in the primary position (that is, when the two visual axes are parallel and in a horizontal plane), the light strikes identical points of each retina. The eyes are in this position when we gaze at a star in the heavens. (2) When the eyes are in a secondary position (that is, when they are adapted for distinct vision of a near object), the visual axes converge so as to intersect at the fixation point, and lie in a horizontal plane. The angle of adaptation varies with the distance of the object, and goes parallel with the accommodation of the lens and the iris.

131. The Cyclopean Eye.—When a near object is fixated with both eyes, then two distant objects—one in the line of vision of the right eye, and the other in that of the left—appear to be in a single line of vision going from a point midway between the eyes through the point fixated. They appear to be in a straight line with each other in the field of vision, or in the identical place if both are at the same distance from the beholder, as though he were observing them with a single eye situated midway between his two eyes (the Cyclopean eye). The two distant objects may combine into one, as when they are two disks of complementary colors, or their impressions in consciousness may alternate because of the rivalry of the different fields of vision in which each of them is located.

This is Hering's law of the identical direction of vision. Its importance for psychology lies in the

fact that the localization of perceptions on corresponding, or approximately corresponding, points of the retina in the field of vision does not agree with the actual position of the perceived objects in space.

132. Disparation.—Disparation is the incidence of light rays from an object on non-corresponding points of the retinas, resulting in double vision of the object. When an object of which we have double vision is nearer to us than the fixation point, its disparate perception localizes it on the side opposite to the eye forming the image. This condition is termed crossed disparation. But when the object seen in double vision is beyond the fixation point, it is localized on the same side of this point on which the eye perceiving it is located.

133. Depth Vision.—When there is a slight disparation of the retinal images, we have a plastic perception of the objects thus seen. They stand out in relief from their surroundings. The relief perspective of the stereoscope is a practical application of this phenomenon. Each of the two stereoscopic pictures is taken from a position corresponding to that of the respective eye. The cameras are placed about 60-65 mm. apart. The plasticity of the picture is increased if the cameras are placed at a distance of 70-75 mm. from each other. In this case the background appears deeper, and the objects seem to be nearer than the distance at which they were photographed. When the two pictures are viewed through the stereoscope by direct vision, the visual perceptions of them are fused into one.

134. Empty Space.—The perception of empty space between the eye and the object seen, and between objects lying in different depth planes, is

founded on the position of objects in different vertical planes and on their relations of distance and direction. Empty space is perceived as though it were filled with voluminous, transparent, visual properties of the black-white series, varying according to the illumination. The perception of empty space is further aided by the luminosity of the surfaces and angles of colored objects in its immediate vicinity and by their varied illumination, depending on the position of the beholder and that of the source of light.

135. **Original Depth Perception.**—It is beyond doubt that experience plays an extensive and important part in perfecting depth perception. Even after much experience, the perception of the third dimension remains subject to serious errors. Two objects in the far distance may appear to lie in the same depth plane, although the one may be much farther from us than the other. We have no perspective whatever of the relative distances of the stars from one another, nor have we a plastic perception of any star.

Yet, the empiristic view that binocular vision is devoid of original depth perception appears improbable. (1) The field of vision contains the only visual material available to us for the formation of visual depth perceptions. Experience cannot create this fundamental element into the plane of vision (Section 127, 2).

(2) The necessity of convergence and accommodation for the distinct vision of objects presupposes original depth perception. If our original field of vision were only two-dimensional, convergence and accommodation would be superfluous.

(3) Crossed disparation fails to account for depth perception, because it is unperceived in the binocular field.

(4) A two-dimensional field may be visually perceived as three-dimensional, as in the case of a photograph of a landscape, and a three-dimensional field may be perceived as two-dimensional, for example, the starry sky.

(5) The objective causes of the perception of empty space (Section 134), especially the visual properties of the black-white series, are the factors giving rise to the original depth perception, which is, at least in the beginning, quite vague and indefinite.

The original and fundamental depth perception is greatly perfected by perspective differences in the two uniocular images, movements of the eyes and the head, changing lights and colors, remembered images, and other secondary factors.

136. Visual or Apparent Size.—The visual or apparent size of an object in the visual field, as distinguished from its real size in space, is not in itself a true criterion of distance. A pencil held at arm's length may have the same size in the field of vision as a house across the street, yet we are under no illusion as to the real size and distance of these objects. The relation between the visual size and the real distance of objects from us is partly determined by the projection and measurement of an imaginary line from ourselves to the object, or by estimating the distance between the intervening objects. When such lines cannot be projected between two objects and other criteria are not available, we cannot estimate their relative distance. Thus, we are unable

to estimate the relative distance of two stars, because we cannot draw a forward line from one star to the other.

In addition to the measurement of the intervening distance, all the other empiric depth signs are applied in determining the real distance of different objects having the same visual size in our perception.

§ 6. UPRIGHT VISION

137. The Inverted Image.—The image of the object perceived is inverted on the retina, because the light waves from the object intersect in the nodal point of the eye. When we see a motor car, its retinal image shows the wheels at the top, the occupants upside down, and the top of the car on a lower part of the retina. Why do we perceive the car in its normal upright position despite its inverted image in the eye?

138. Theory.—Upright vision does not consist in projecting the retinal image back into space and thus righting it, because the object is perceived, not in the retinal, but in the psychic image.

The spatial orientation of the psychic image is identical with that of the retinal image, because the latter is the cause of the former. The street, the foundations of buildings, the base of a tree, our own feet, and the feet of others are localized in the same area. Tactile sensations convince us that this localization is correct. We also feel the ease of "downward" movements, which is caused by the influence of gravity. Furthermore, long experience brings about the fixed association of these visual perceptions and kinesthetic and tactile sensations into a

habitual representation and expectation of the downward position and direction of these objects.

In this way we perceive the localization of the sky, the roofs of buildings, the tops of trees, our own head, and the heads of others localized in another area of the visual field. We likewise feel the greater effort required for movements in the direction of this field. Experience associates these data and thus gives rise to the habitual representation of "upward" direction and position.

Since the normal and predominant position of the human body is that with the head away from the earth and the center of gravity, we consider all objects that are normally orientated in the same part of the visual field as the head, when the latter is in this position, to be likewise in their normal position if we perceive them in this visual area.

Hence, the perceptions of "up" and "down" are based on the association of our awareness of the normal position of the head and body with the corresponding orientation of objects in space as then given in the visual field.

139. Stratton's Experiment.—This is further proved by Stratton's well-known experiment, in which he wore a lens attached to the eye, inverting, and consequently righting, the retinal image. At first he saw everything upside down, and experienced great difficulty in coördinating his movements with the new position of objects in the visual field, because he could not at once break the lifelong associations between perceptions based on the inverted retinal image and their corresponding kinesthetic and tactile sensations.

But after a week, when he had overcome these

former associations, the unusual position of the field of vision no longer seemed inverted to him, and his movements, especially in quick and unreflective actions, were for the time being fully and accurately coördinated with the new localization of objects in his visual field. When the lens was removed at the end of a week's uninterrupted experiment, and the inverted image on the retina was thus restored, Stratton for a few hours saw objects in a confused manner, but not in an inverted position, and his movements were no longer coördinated with the restored normal position of the objects in the visual field.

§ 7. OPTICAL ILLUSIONS

140. The Problem.—The difficulty of distinguishing original from empirical factors in visual perceptions of the third dimension and of the form of objects has given rise to various explanations of the numerous optical illusions we experience in everyday life. Straight lines are considered curves, equal distances seem unequal, parallels appear at an angle, and in general, our visual impression of the size, distance, and shape of objects are often at variance with their true spatial properties. This is the more remarkable since the differences of these impressions from the realities causing them frequently persist even after we are convinced of the fallacy. The psychological problems of optical illusions of the eye lie in the questions of their nature and their cause—whether they are misperceptions, erroneous judgments of the mind, or effects of association and spontaneous interpretation that must be corrected by investigation.

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141. Classification.—The following are some of the important classes of optical illusions.

(1) Geometrical optical illusions are errors in the perception of lines, angles, and spaces in a two-dimensional plane.

(2) Illusions of perspective are found in ambiguous line-drawings, in which the direction of depth lines may be differently interpreted.

(3) Illusions of motion are caused by the rate and direction of motion, as exemplified by the apparently continuous motion of objects seen in moving pictures.[3]

142. Theories.—Geometrical optical illusions have been explained by the reflex movements of the eyes induced by the observation of these figures (WUNDT), by the association of the figures perceived with the varying perspective experienced in everyday life (THIÉRY), by the vitalizing play of the imagination (*Einfühlung,* LIPPS), and by the concentration of attention on a part of the figure (MÜLLER-LYER). Since none of these theories has been established to the general satisfaction of psychologists, it is sufficient to mention them here. Probably all the factors enumerated are concerned in optical illusions.

§ 8. THE PERCEPTION OF TIME

143. The Problem.—Our perception of time is based on the time properties of objects as given in the immediate data of consciousness. Every act of consciousness precedes or follows another act and possesses a certain duration, but our perception of these time properties does not always correspond

[3] EBBINGHAUS, II, 51-121, and LADD, *Elements of Physiological Psychology,* 437–450, have many examples of optical illusions.

to their objective reality, nor do we perceive them in every instance. The constant error made by the observer in estimating the moment of the transit of a star across a thread in his telescope—known as the personal equation—is a familiar example of the divergence of time perception from time properties. The personal equation involves the two errors of simultaneous happening perceived as successive, and of successive happening perceived as simultaneous.

The chief psychological problems of time perception are the questions of the foundation and the genesis of our consciousness of time properties. The general questions of the reasons why physical change takes place in time, and in virtue of which properties things exist in time, are studied in other sciences.

144. What is Time?—Successive duration is the essence of time. Our perception of time is usually that of a succession of acts or events in our consciousness, but this succession of distinct acts is purely accidental in time perception. Time is continuous. In the strict sense, it is the perception of the successive duration of things subject to substantial change, entirely apart from the actual occurrence of change in them. A material being in which no change whatever takes place is nevertheless in time. But since the stream of consciousness is constantly changing, our time perceptions are commonly based on the succession of conscious acts, or on the successive phases of a single act.

The perception of the simultaneity of several sensations, especially when they are disparate, is involved in difficulties arising from the different

lengths of the conducting nerves, the greater or lesser rapidity of the phases of different classes of sensations (Section 75), the influence of expectation, and other causes.

145. Intervals of Time.—The perception of time is made up of psychological instants. A psychological instant is the shortest duration perceptible. It differs from the mathematical instant, which is durationless.

An interval of time is successive duration between any two instants. It is said to be "filled" when we notice the successive acts occurring between the two instants; it is "empty" when we notice only these two instants, but not the intervening acts. In reality, no interval of time is quite empty, since it is actually filled at least with kinesthetic and organic sensations.

146. Estimation of Time.—The estimation of time is either objective or subjective. Objective estimation is the comparison of a given interval with objective measures, as seconds, minutes, etc. Subjective estimation is the characterization of an interval as "long," "short," "moderate," etc., without reference to objective measures.

Estimation is direct when we have the simultaneous consciousness of the measure and the interval that is being measured. It is indirect when it is determined according to empiric time signs, such as feelings of expectation or surprise, tension or release, sensations of haste or delay, the periodicity of organic sensations (heart-beats, respiration), etc.

Subjective estimation is often at variance with the true duration of the interval. When we wait impatiently for the change of a traffic-signal, the inter-

val between signals seems long; but, if we measure it by the duration of so many seconds, it is quite short.

147. The Psychic Present.—The brief interval during which our conscious acts actually remain in our consciousness, is termed the psychic present. Introspection shows that, when we spell out a word such as "now," the three letters of which it is composed appear successively in our consciousness, but that the first two are still present in it, and not merely remembered, when the last letter is spoken.

The span of the psychic present is short. It has been estimated as continuing from two seconds to two or more minutes, but exact measurements are exceedingly difficult, if not impossible, because the transition of a content from actual to recalling consciousness is gradual and continuous, and because the changing direction of attention seems to contract the succeeding intervals, and thereby to approximate the successive contents of the psychic present to one another as they are progressively receding into the past.

148. The Perception of Succession.—Successive perception is not identical with the conscious perception of succession, which is the time character of objects and states of consciousness to be investigated here. The perception of succession is a third factor, distinct from the perception of objects, acts, and their phases succeeding one another in our consciousness, as well as distinct from the perception of our being conscious of these objects, acts, and phases.

The successiveness of the content present to us in our consciousness and of the act of being conscious

of it is the ontological foundation that makes possible the actual perception of successive duration within the psychic present. The perception of successivity within the psychic present appears to be reasonably explained by our consciousness of the successive direction of our attention from one content of consciousness to another within the psychic present.

149. The Threshold.—The method of measuring the various thresholds of the perception of time does not consist in varying the duration of the stimulus, since the duration of the sensation caused by it, by reason of its phases of rise, culmination, and fall, exceeds that of the stimulus. Even the alternative method of estimating the blank interval between two sensations is fraught with considerable difficulties, because the phases of the first sensation may protrude into the intervening interval. The smallest interval perceptible varies from about 0.04 second in the case of visual sensations to about 0.002 second for auditory sensations.

The threshold of discrimination for the determination of which two sensations are compared, in order to ascertain the perception of the difference of their duration, varies according to the duration of the sensations and the length of the intervening interval. Variations of 1/20 to 1/30 from the duration of the original stimulus are perceptible. Expert observers are said to distinguish variations of 1/100 from the duration of the original stimulus when the stimuli differ from one another by 0.3 second duration. The smallest interval thus discriminated is said to be 0.003 second.

150. The Indifference Interval.—Generally speak-

ing, short intervals are overestimated, and long ones underestimated. The indifference period is the point of transition between the former of these errors and the latter. It is, therefore, the interval that is on the average correctly estimated. Myers [4] gives the indifference interval as 0.7 to 0.8 second, Fröbes [5] as 0.5 to 0.6 second. Greater intervals are underestimated, lesser ones overestimated.

151. Subjective Determinants.—The chief determinants in the subjective estimation of time are attention, expectation, and surprise. When our attention is steadily centered on the work we are performing, we underestimate its duration, and the hours and even the years "pass rapidly." But the absence of a desirable object to which the attention may be directed, or the necessity of compelling the direction of constantly wavering attention toward uninteresting or disagreeable subjects, results in the overestimation of duration, so that the hours seem to "drag along."

The expectation of a future event causes the overestimation of the interval preceding it, and it may lead to the formation of pre-percepts. When we are awaiting the arrival of a friend, a few minutes of delay appear "long," and we may "hear" his step before it is actually audible.

When the expected event is accompanied by elements of surprise, the recollection of the period of waiting tends to underestimate its duration as long as the effect of surprise is present.

152. Rhythm.—Rhythm is the organization of successive experiences into a regular series by group-

[4] *Textbook of Experimental Psychology,* Vol. I, p. 299.
[5] *Lehrbuch der experimentellen Psychologie,* Vol. I, p. 384.

ing them into identical units provided with stress. The mind's tendency to reduce particulars to synthetic units causes the rhythmization especially of auditory, kinesthetic, and tactile sensations, usually into groups of two or four units, and with a predominance of descending over ascending rhythms. Rhythmization produces motor innervations that are likely to seek an outlet in rhythmic movements of the head, the hands, the feet, or the regular swaying of the body. The beats of a metronome and the ticks of a clock or a watch, perceived as series of two or four, are simple examples of spontaneous rhythmic grouping.

The apparent length of the accented unit, the seeming brevity of the unstressed units, and the apparently longer interval between the end of one rhythmic group and the beginning of the next are subjective estimations of duration caused by rhythmization. The arrangement of the rhythmized elements into groups of two or four seems to be a consequence of the natural simplicity of these groups —the second being the next multiple of the first— and of the facility of centering attention on them over a long period of time. The difficulty of forming larger rhythmic units is evident from the effort required to place the accents correctly in slow music with six or nine beats to the measure, and to bring out the rhythmic structure of musical periods.

153. Time Displacements.—Attention has already been directed (Section 143) to the fact that two stimuli simultaneously applied to different senses do not usually produce simultaneous sensations. When a visual and an auditory stimulus are applied to the respective senses at the same time, the re-

sulting auditory sensation precedes the visual sensation. If the simultaneousness of these sensations is desired, the visual stimulus must be applied from 0.06 to 0.1 second prior to the auditory stimulus, because visual sensation has a longer period of latency than auditory sensation. Attention and expectation are subjective causes accelerating the perception of the stimulus. Experiments are usually carried out by means of Wundt's "complication clock."

§ 9. REACTION TIMES

154. Reactions.—Many interesting and delicate experiments have been made to determine the time required for the performance of psychic acts. Absolute measurements are hardly possible, because the interval that elapses between the application of the sensory stimulus and the muscular response to it, and the brief period necessary for the transmission and expression of the efferent impulse, cannot be computed. But even a careful study of the total reaction time, extending from the application of the stimulus to the outward expression of the response to it, reveals many facts about the comparative rapidity with which the different senses respond to stimuli, the time employed for the formation of certain associations, the facility of recall and recognition, the formation of judgments, etc.

A reaction is the psychic response to a known sense stimulus. When a series of differently colored disks is presented to the eye, the reaction may consist in naming the colors. The reaction time is the interval that elapses between the application of a known stimulus and the prescribed reaction to it.

In the above example it is the time from the instant at which the colored disk is presented to the instant at which the name of the color is spoken.

155. Simple and Composite Reactions.—A simple reaction is the immediate response to a previously known, simple stimulus. The naming of the sensation of blue on the presentation of a blue disk to the eye is a simple reaction. A compound, or composite, reaction is the response to a stimulus into which a complicating process has been introduced. When two shades of red are successively presented to the eye, and then presented together, the identification of the disk that was first presented is a compound reaction.

156. Measurements.—Reaction times are measured by means of very delicate instruments, of which Wheatstone's chronoscope is the prototype. The chronoscope is an electrically operated clock recording the thousandth part of a second. Its operating circuit is completed simultaneously with the application of the stimulus, thereby actuating the chronoscope, and broken when the prescribed reaction takes place. Accurate results require, not only a careful and frequent control of the instrument, but also an extensive series of experiments under identical conditions.[6]

Reaction time differs, not only for the different senses, but also according to the direction of attention. When attention is concentrated on the stimulus, the reaction is termed sensorial; when it is directed to the muscular movement breaking the circuit and thereby indicating the reaction, the re-

[6] The construction and operation of Hipp's chronoscope is described in MYERS, *Textbook of Experimental Psychology*, Vol. II, pp. 44–50.

action is designated as muscular; when it is undirected, the reaction is said to be natural or indifferent. Muscular reactions are more rapid than sensorial reactions.

The following table of reaction times for the various senses and forms of reactions is quoted from Myers:[7]

	Muscular reaction	Sensorial reaction
Sound	0.125 sec.	0.220 sec.
Light	0.175	0.270
Touch	0.110	0.210
Heat	0.130	0.190
Cold	0.115	0.150

157. Composite Reactions.—Recognitive, discriminative, choice, and associative reactions are the chief classes of composite reactions. In recognitive reaction the exact stimulus is unknown to the subject beforehand, and he performs the required muscular reaction only after he has fully recognized or identified it. For example, a series of letters, figures, or signs is presented to him, and he presses the key that breaks the circuit only after he has definitely identified them.

For discriminative reaction a similar series of stimuli is presented, and the subject is instructed to react only on the stimulus previously determined. In the presentation of a series of figures, he may be requested to react only when the figure 3 is presented.

Choice reaction is more complicated, because it involves a choice between the stimuli. A series of figures is presented to the subject, who is enjoined to raise his right hand whenever the figure 3 ap-

[7] *Op. cit.*, Vol. I, p. 126.

pears, and the left whenever the figure 8 is shown.

Associative reaction experiments require the subject to associate an idea with the stimulus presented. A series of adjectives may be read to him, and he is to name a noun to which each can be applied. Foreign words are presented for association with the corresponding term in the vernacular. Numbers are presented, and various mathematical calculations required as associations.

158. Variations.—Practice lessens the reaction time, as the subject becomes better adapted to the conditions of the experiment. During the course of a series of experiments, the reaction movement may become entirely reflex. In childhood and old age, reactions are slower than in the intervening periods. Some persons have a leaning toward sensorial, others toward muscular reactions. Complex reactions are naturally slower than simple ones. Fatigue and attention also lengthen the reaction time.

Collateral Reading.—Warren, *Human Psychology,* Chapter XII (Perceptions); Seashore, *Introduction to Psychology,* Chapters IV and VIII (Visual Space; Traits of Perception); Ladd and Woodworth, *Elements of Physiological Psychology,* Part II, Chapters IV–VI (Sense-Perceptions; Time-Relations); James, *Principles of Psychology,* Vol. I, Chapter XV (The Perception of Time).

Seashore, *Elementary Experiments in Psychology,* Chapters IV–VI (Visual, Auditory, and Tactual Perception of Space); Chapter XIV (Normal Illusions); Chapter XVI (Reaction-Time); Snow, *Problems in Psychology,* Chapter VI (Perception).

CHAPTER VII

SENSE REPRESENTATIONS

§ 1. THE NATURE OF REPRESENTATION

159. Representation and Sensation.—(1) Hume distinguishes sensations from other cognitional contents by their intensity. This is a common but merely accidental distinction between sensation and representation, for sensations may be weak and indistinct, and representations may be forcible and intense. Dreams and hallucinations, which evidently are not sensations, may be as intense, distinct, and vivid as sensations.

(2) Representations are often incomplete images of their objects, and devoid of individualizing marks. A representation of a building in most cases contains only a part that we have frequently seen, and even this part, as contained in the representation, may be vague in outline and color. But these characteristics are only accidental distinctions between sensations and representations, for the former may be incomplete and vague, and the latter highly individualized.

(3) Representations frequently dissociate their object from its environment in space and time. The spontaneous representation of a building does not usually give us a definite setting in time, with the

attendant lights and shadows, and preceding and succeeding events, nor a setting in space with the environment of its neighboring structures, the adjacent streets, and the people and vehicles passing by.

Dissociation from time and space is the foundation of a negative distinction between representations and sensations, but it is not a distinctive characteristic of the former. Illusions and abstract concepts are not images of things existing in the outer world, but they cannot be identified with representations. Hence, if a cognitional content is without actual relation to real time and space, it is not a sensation, but either a representation or another form of cognition. A representation is the psychic image of an object that belongs neither to the outer world of sense objects nor to the inner states and acts of which we are conscious, but this dissociation from the outer world and from inner happenings does not necessarily make the object so dissociated become a representation. Separation from these two realms does not make any psychic content a representation, but follows from the fact that this content already is a representation or another kind of psychic act sharing the properties of timelessness and spacelessness with representations.

(4) Sensations result from the excitation of sense organs, representations originate without it. But difference of origin does not alone suffice to differentiate the nature of the product. The foregoing illustrations have shown that the content of representations may be identical with that of sensations. The act by which this content is produced remains as the only possible foundation on which a

justification of the distinction between sensations and representations can be sought.

160. Nature.—Representation is the act of rendering present in sense consciousness an object that is not in itself present to the senses. The essential difference between sensation and representation consists in the fact that sensation is caused through the stimulation of the senses by the object actually present, but representation is either a sensory image evoked from memory, of an object previously perceived, but not now present to the senses, or it is produced by combining memory images, or parts of them, into a new sensory image by the imagination. In our everyday experience, and in general when the faculties are normal, we are aware of the ontological existence of sensory objects when they are perceived, and of their non-existence when they are merely represented. Both sensations and representations are perceptions—in the wider sense of sensory cognition—the former perceiving a real object of the outer or the inner world, and the latter perceiving an image of such an object, caused by memory or imagination.

Representations depend on sensations for their origin. No matter how unreal and fantastic the images of the imagination may be, they are in every instance combinations of remembered images, or parts of such images, originally obtained by sensation. In the absence of sensation, the images depending on the corresponding sensations are lacking in the imagination. One who is congenitally blind and deaf cannot imagine sounds and colors. Sensations are perceptions—in the wider sense of the term—of peripheral origin; representations are

those of central origin. The central organs cannot function unless they have previously been at some time actuated by peripheral stimulus.

Imagination and memory perform a highly important service by enabling us to plan and design external acts and things, and to control their execution by comparing it with their representations in memory and imagination. The natural limitation of the imagination to the combination of elements derived through peripheral stimulus, and the comparatively fleeting and ordinarily less vivid character of representations is a useful check on psychic life, because it prevents fantastic central activity and directs man's activities toward the realities of the world in which we live, and toward the intellectual and moral implications that are given with it.

161. Properties.—The properties of representations are those of the sensations they reproduce. A single representation may be derived from sensations of different kinds, and therefore possess their properties. The representation of an orange may have its origin in sensations of sight, touch, smell, and taste, and possess their properties. But these properties of representations are not capable of the minute variations found in sensations. Quality, intensity, and time and space characters are the properties of representations.

Empiric properties, distinguishing sensations from representations, are useful as secondary criteria to distinguish these two forms of sense cognition. As compared with representations, sensations are endowed with greater invariability of the image,

fixed persistence, definite position in space, greater distinctness of spatial properties, greater vividness, sudden appearance in consciousness, instant disappearance when the stimulus is removed, and dependence on the present condition of the peripheral organ.

162. Classification.—Representations are either simple or complex. Simple representations are memory images, reproducing more or less faithfully the sensations to which they owe their origin. Complex representations are combinations of memory images, or parts of them, reproduced by the imagination, which is free to build up in many ways the elements treasured in the storehouse of memory into new units, ranging from perfect counterparts of possible sensations to weird and grotesque fantasies impossible of realization.

Both simple and complex representations may be either individual or generic. Individual representations are more or less faithful psychic images of individual objects. Thus, we have individual images of objects and of our own inner experiences. Generic images reproduce properties common to a class of objects, and they originate by the superposition of individual images and the obliteration of their individual characters. Representations of a tree, a rose, a man, a toothache, darkness, rain, etc., are generic images.

Visual, acoustic, motor, and emotional types of representations are distinguished according to their predominance in memory and imagination. In order to determine the type that predominates in a given person, it is not sufficient to ascertain which type is most prominent in a series of experiments devised

for the purpose. The results of this investigation must be controlled and rectified by a study of his psychic life in general, which reveals the habitual, and therefore on the whole predominating, type of representation. It need hardly be added that no single type predominates to the total exclusion of others. A type of representation is merely the natural or acquired psychic preference of memory or imagination for representations corresponding to a given quality of sensation. Mixed types are common.

The experimental study of types of representation has been mostly confined to those predominating in the tests themselves. Experiments in the learning of words, figures, and sentences furnish a large part of the data of these investigations.

In the visual type, the words or figures are represented as written or printed on a page. Persons of this type work somewhat slowly, because of the time required to visualize the objects distinctly, but pronounced visual types assimilate a considerable amount of material at one time, together with its background. Visual representations predominate when difficult matter is to be memorized—*e.g.*, foreign words and strange signs. A pronounced visual type is usually also a strong acoustic type.

Visual representations are localized in different ways. The object may be isolated from its environment, or represented in its natural setting and connection. The subject may transport himself mentally to the natural place of the object represented, and behold it from his habitual or from an arbitrary position; or he may bring the object in spirit to the place where he actually is, and see it where

he would conveniently use or place it. The object represented has the visual size it would possess if actually localized with reference to the imaginary position and distance of the subject. Objects are projected through the walls of the room where he beholds them, in order to give perspective to the representation, and the sensation of the walls is completely obliterated from his consciousness. The objects may be seen in the line of vision, and move with it from place to place.

The acoustic type hears the printed words he is memorizing as though he were speaking them with his own natural cadence, intonation, and inflexion. In representing musical sounds, however, the power of imagination has almost as wide a range as the capacity of the ear for sound. A pronounced acoustic type is not usually a strong visual type.

The motor type represents to himself the movements of the vocal organs when learning words. In his imagination he enacts the kinesthetic sensations that would accompany his speech, and often he speaks the words as he is learning them. He may go through the movements of writing them, in imagination or in reality. If he is a pronounced motor type, he may direct an imaginary orchestra and dance to its music when reproducing or memorizing it.

Representations of objects are said to be most intense in women, teachers, and physicians. The pronounced visual type of object-representations is often associated with strong personal initiative in practical work. A pronounced motor type is usually a person of strong feelings, which he delights to heighten or to excite by motor representations.

Loss of sensation does not destroy the corresponding type of representations. Beethoven produced his greatest masterpiece after he was completely deaf. A life devoted to the study of abstract science weakens the power of representation.

§ 2. MEMORY

163. Recall and Recognition.—Recall and recognition are the acts of memory. Recognition is the identification of a present experience with one's own past experience. When we listen to an unknown speaker at a conference, it may suddenly dawn on us that we passed him on the preceding day and heard him greet an acquaintance. Now we recognize his features and his voice, and we ask our neighbor: "Who is he? I saw him yesterday." This is an act of recognition, because, as we regard the speaker, we identify our present sensations, produced by his voice, with similar sensations of our own in the past.

Recall is the reproduction of a past experience in the form of a more or less faithful representation. Some days after the conference just mentioned, a friend may ask us: "Did you hear Mr. X.'s address?" The mention of the gentleman's name at once brings up in our consciousness his appearance and voice. This is an act of memory that differs from mere recognition, for in the present case the name, not the sight of the person, causes the representation of his appearance and voice in our consciousness.

When the representation thus produced by memory is identified as a part of our past experience,

we have both recall and recognition. The production of the representation is an act of recall, and its identification with our own former sensations, obtained by direct cognitional contact with the object itself, is an act of recognition.

Recognition is easier than recall, and begins earlier in life. Children are capable of recognition before they are able to recall their former experiences. A witness may recognize persons he cannot recall. If he is capable of recalling the person he recognizes, other things being equal, his testimony is more valuable.

164. Gradual Recall.—Recall is not always instantaneous, and the representation produced in the process of recall often becomes gradually more distinct and complete. In these cases various procedures are resorted to in order to bring up and perfect the image of the object to be recalled.

(1) An imperfect representation may be developed oftentimes by the concentration of attention on it. It develops as we study it. (2) Recall may be effected by allowing attention to take its spontaneous and perhaps fortuitous direction. (3) Recall of environment is another aid to the recall of the object wanted. The setting of time, place, and circumstances, which formed the original entourage of the object sought, are brought back from memory, and they often effect the recall of the desired object because of their connection with it. (4) When these expedients are without avail, recourse is had to reflexion on one's personal habits and on general view-points that are likely to furnish a clue to the experience it is desired to recall.

165. Certainty of Identification.—The conviction

that the identification of our present with our past experience is correct, is one of the characteristic phenomena usually accompanying recall and recognition. This conviction is founded on the existence in the memory image of a greater or lesser number of the individualizing marks of the object remembered. When they are absent from the representation, it is either not recognized, or it is only vaguely felt to be known to us. The persuasion of the correctness of our identification of the representation present in our memory with our past experience varies in degree from absolute certainty to moral assurance, and there may be in its stead uncertainty, hesitation, and doubt.

Experience shows that, even when the subjective conviction of the correctness of our identification of our present representation with our past experience will not admit of the slightest possibility of error, not one but several alternatives may occur. The representation may be entirely true, or it may be only partly true, or it may be completely false. The same contingencies may occur when we doubt the correctness of the representation, and when we reject it altogether as erroneous.

Our attitude of certainty, doubt, and rejection may change from any one of these initial states to any other one. In this case again, our final attitude may either approach the objectively true relation of the memory image to the experience it recalls, or it may depart from it.

Direct errors of recognition are not uncommon. Not infrequently a person or object seems to be known to us at first sight, but is almost immediately found to be entirely strange. Such errors are

caused by the similarity of objects and the vagueness of the memory image.

166. Testimony Based on Memory.—From these observations it follows that, in estimating the evidential value of testimony, knowledge and truthfulness, the moral criteria of credibility, must be supplemented by the psychological test of accurate memory. The experiments thus far made have not yet obtained a general acceptance of their results, but they seem to show a much higher degree of accuracy in reports made by witnesses than in their answers to questions. William Stern's investigations[1] show 90-95% accuracy in reports of witnesses, but only 70-80% in their answers to questions. Descriptive signalments made after the event are unreliable if the attention was not directed to the facts when they took place. Recollection of colors was found particularly subject to error. Hence, it is erroneous to infer that indications of the kinds mentioned are lacking when the witness has not observed them, and his errors do not necessarily militate against his veracity. In historical research, where it is impossible to control the accuracy of a witness directly, the correctness of his statements must be established by other individual criteria and by the convergence of testimony. Suggestion by the questioner is very likely to produce erroneous testimony, especially when he is a person in authority.

167. Theories of Memory.—In seeking a scientific explanation of the facts of memory, psychology is primarily concerned in establishing the general cause of the acts of memory and the laws according

[1] FRÖBES, *Lehrbuch der exp. Psychologie*, II, 153.

to which it operates. What makes it possible to recall our past experiences, and by what means are we enabled to identify a representation produced by this act as an image of a former experience?

A widely accepted theory of retention explains memory by structural modification of the organism. As a wire, once bent, bends more easily thereafter, so the structures involved in acts of memory undergo modifications through the repetition of perceptive acts and retain the ability to respond in a similar manner on subsequent occasions. The modifications asserted are neural effects that endure and modify our present activity.[2]

This theory does not explain the ego's identification of the memory representation with its own personal experience of the past. On the principle of this theory, recall would be simply a new experience without a recognized connection with the past. Furthermore, if memory were merely a similar response, the same object could not be recognized when it stimulates different sensory elements in subsequent experiences. Finally, neither sensation nor memory is a purely physiological process.

163. Memory is not the unconscious nor the unnoticed persistence of perceptions. This theory does not explain why only a small part of our perceptions can be recalled, nor why recall is often gradual. It is frequently impossible to recall a perception only a few minutes after it was experienced. To what purpose would acts of attitude persist in the ego?

169. Psychic acts probably persist in the soul as psychic residues in the form of devoluted cogni-

[2] CARR, *Psychology* (1926), pp. 253 sq.

tional elements, joined by reproductive associations.[3] Without the persistence of some sort of a residue, there would be no sufficient reason for the reappearance and recognition of our previous experience. This residue originates from the original perception and makes possible its recall and recognition. The process of memory is the renewal or reproduction of the original perception in the form of a representation. The recall of a former experience, therefore, differs in important particulars from the perception it renews. The memory representation is not a true reëxperience of the original perception, because it has a different form. When we recall a journey, we do not make it again with its attendant circumstances of novelty, new acquaintances, fatigue, excitement, and expense. The recalled experience comes back to us gradually, practically always in an incomplete state, and often with numerous particulars altered. The reproduction of a former experience by memory is, therefore, the formation of representations through the cooperation of cognitional residues with various other psychic factors.

170. This hypothesis has the merit of offering a really sufficient reason for recall and recognition, although, like every other theory devised to explain memory, it has not been verified experimentally. It assumes that, when perceptions recede out of consciousness, they are reduced to a primitive and rudimentary state similar to that of the initial psychic stage of the act of perception. As long as they remain in this condition, they are indistinguish-

[3] Cf. GEYSER, *Lehrbuch der allgemeinen Psychologie,* II (1920), pp. 198–206.

able from one another, and hence unnoticeable. They are the psychic material on which the soul works in the acts of memory and in the combinations made by the imagination during wakefulness and in dreams. Since our perceptions are joined by associations and interactions of many kinds when they first appear in consciousness, their psychic residues also retain these connections while they are latent in the memory. In this way the recall of the associated objects as a unit, and errors in identification like those mentioned in SECTION 165 sq., are plausibly explained as displacements and disarrangements of these residues and the representations produced from them. To these errors should be added errors in judgment in interpreting the sensory content of cognition.

171. Immanent Association.—The percepts that constitute our cognition and contain the objects we remember, are composed of many cognitional elements. We retain the name, the appearance, the voice, and the personal traits of the people we meet. Besides these simultaneous groups of cognitional elements, we remember successive series, such as a list of the names of the Presidents, or the number of lines on a page, or the words in each line. Since these simultaneous and successive groups are perceived and remembered as units, there is a unifying factor binding them together into a whole. This factor is called association. Since it unites the various contents of consciousness while they are being perceived, it has been called immanent association.

172. Reproductive Association.—The recall of a complex content of consciousness is usually a gradual process. One after another, the characteristics

of a person we have seen appear again in our memory, until finally after some moments or minutes we have a fairly complete psychic image of him. As we silently recite the list of the Presidents to ourselves, they appear one or two at a time in our consciousness. Hence, there is a psychic bond that continues to join the residues of former percepts even during the period of latency, and enables us to recall together what we previously perceived as a unit. This factor, which may be termed reproductive association, enables us to recall into consciousness successively the remaining elements of an associated group in various stages of development, ranging from dim awareness to full actualization, when one member of the associated group has been brought back into consciousness.

Like the cognitional elements it contains, the factor constituting immanent association probably undergoes a process of devolution, reducing it to the rudimentary state in which it serves as the reproductive association factor. As the following pages will show, association is effected principally by relational acts of the soul.

§ 3. ASSOCIATION

173. Association and Memory.—Association is the psychic process in which past cognitions are brought into consciousness by their connection with others present in it. The study of association, therefore, will project much light on the problems of retention, forgetting, and the formation of the basis of recall and recognition.

The experimental investigation of association es-

tablishes the empirical foundation of recall and recognition, and the conditions favoring it. (1) The total amount of work required can be calculated by the number of repetitions necessary to remember a given subject, the total amount of time consumed in the task, and the rate of speed at which the associations are established. (2) The effectiveness of the association formed is determined by slow or rapid, complete or partial recall. (3) The duration of the association is established by computing the total time during which complete recall is possible, the rate of forgetting, the interval elapsing before the subject is entirely forgotten, and the work then required for rememorizing it.

The aim in this investigation is to determine as far as possible the causative factors of retention, reproduction, and recall, and their influence.

174. Methods of Experiment.—Letters and syllables are the most suitable material for the study of association, because they reduce the experiment to its simplest form. Prose, poetry, and isolated words are not in the same degree serviceable material for memory experiments, since they do not permit the separate study of the influence of the various factors contributing to the formation of associations.

The chief methods devised for the study of association are those of learning, saving, scoring, and prompting.

In the learning method, a series of meaningless syllables is read or successively shown to the subject until perfect recall is effected, and the number of repetitions necessary for perfect reproduction is noted.

In the saving method, the matter is memorized as in the learning method, and then the power of recall is tested after the lapse of varying intervals to determine the duration of association and the proportion of the material remembered during each interval.

In the prompting method, the material is imperfectly memorized, and the number of prompting repetitions necessary for the production of perfect recall is calculated.

In the scoring method, the syllables to be memorized are read in pairs, but not often enough to establish perfect recall. Then the first syllable of each pair is read again after varying intervals, and the subject is required to supply the second from memory. The "score" is determined by the proportion of correct answers.[4]

The learning, saving, and prompting methods supply data on the memory of an entire series of letters or syllables; the scoring method furnishes information on the association of pairs. In the learning and saving methods the weakness of the power of associating the members more difficult to recall is favored by repeating them oftener than the members more readily remembered. In the scoring method the results can be noted at any time, and it is independent of the strength of association. All these methods may be modified and complicated for the study of more difficult problems of memory.

The following table of results obtained by the learning method illustrates the influence of the

[4] Practical directions for conducting experiments according to these methods are given by MYERS, *Textbook of Experimental Psychology*, II, 55–57.

length of a series on the number of repetitions required for perfect recall:[5]

Number of syllables in series	7	12	16	24	36
Number of repetitions needed	1	16.6	30	44	55

175. Causative Factors.—Mere juxtaposition or succession is not sufficient to effect association and to enable us to recall the objects perceived, for we see and hear many things daily without afterwards being able to recall them. Few persons can recall the number of motor cars passing them on a busy street in a given space.

What appears to be purely mechanical memory actually includes many psychic acts that have taken place without reflex consciousness and attention. Incidental facts and trivial occurrences of no consequence come to be remembered because of their connection with the object to which attention is directed.

Hence, the causative factors of association and memory are to be sought outside the field of mere juxtaposition, immediate succession, and mechanical perception. The analysis of experience shows that unification, the establishment of concentrated attention, direction of will, and intellectual penetration of the subject-matter are the causative factors of association.

176. Unification.—The mind endeavors to perceive and seize the subject-matter in one glance, and to peruse it rapidly once more by swiftly running over its parts in their given order with the eye or the imagination. This process of association is very

[5] From Myers, I, 148.

common among younger children, who take a last glance into their books and follow with the finger the words of a line to be memorized.

177. Relations.—The perception or the establishment of relations between things to be remembered is a powerful factor effecting associations. Careful examination of the subject-matter may disclose a variety of relations. The building we are endeavoring to locate may be the highest in the block, and it is thus easily remembered by reason of its contrast with its environment. If we are to remember the number 248, we recognize that the second digit is double the first, and the third double the second.

Localization in the visual field or on the printed page is a spatial relation that aids the memory. Names that are to be remembered are visualized in their proper places on the page, and spatial relations established between them. It is easier to recall the page as a whole, and the names desired are seen on it as it appears before the imagination. Memory specialists have elaborate schematic diagrams into which they fit long numbers, extended series of letters, and complex formulas.

When associating relations do not exist between objects to be remembered, they must be established arbitrarily. "Burns, Oates & Washbourne" may be remembered by the initial letters joined into "BOW." "Scribbler" may furnish a clue to the meaning of "*scriba*," "library" to that of "*liber*."

Relations are often discovered by dividing a long series into sections and studying their relations to one another. Numbers may be separated into groups of three digits, and the relations between these sections often suffice to fix them in the memory.

178. Rhythm.—Rhythm favors the association of meaningless syllables as well as that of the metrical forms of prose and poetry. Metrical groups are perceived as units, metrical stress binds them together, and the regularity of the rhythm prevents the substitution of false terms. Rhythmic stress concentrates the attention, and the variety of metrical structure tends to hold it by reason of its change and novelty. The ease with which simple verse is memorized is an illustration of the associating value of rhythm.

179. Attention.—The distinct memory of things that in past years spontaneously arrested the attention affords better proof of the strong associations established by attention than experiment could furnish. Even without the intervention of the will, attention may establish lasting associations extending to the details of unimportant but keenly perceived events. During the process of spontaneous attention, the soul is completely absorbed in its object by such activities as steady contemplation, close logical analysis, and detailed apperception. Relations of detail, perceived in the object and its connection with others, leave a corresponding number of psychic residues in the soul, and so form the associations that serve to recall the object even after an extended period of time. According to the theory explained in Section 169 sq., these residues, in their state of devolution, constitute the psychic basis that makes recall possible. It is to be remembered, however, that they are not in every instance sufficient for actual recall, especially when the object is strange to us and contains difficult details. In the latter case, inability to recall the object is trace-

able to dim or fleeting perception of the relations forming the basis of recall.

180. Will.—The influence of the will on the formation of associations is different from that of attention. The action of the will on the process of memorizing consists in intensifying the cognitive acts and causing the mind to rhythmize and analyze the material. Hence, the will exerts its favorable influence on the process of memorizing in an indirect manner by stimulating the activities of the soul, by bringing about a more general application of the factors that lead to the formation of associations, and by effecting the selection and continued intensive application of those best adapted to the material in hand. The will brings about the frequent repetition of the matter and the intensive application of the association factors which are found most serviceable in the individual case, and without the use of which associations of sufficient strength for the recall of complex and extensive material would not be formed.

181. Rationalization.—The material to be memorized is retained quicker and for a much longer time when the intellect is enabled to grasp it as possessing meaning, or making sense, than in the cases where the mind is confronted with the problem of memorizing a meaningless content. This fact has given rise to the art of mnemonics, which among other things supplies principles and rules for devising a rational interpretation of meaningless material, and for making apparent logical relations that are not spontaneously perceived. Thus, meaningless material is transformed into an intelligible content and memorized with comparative

ease. The advantage of rationalizing a meaningless content is evident in the case of dates, numbers, formulas, and foreign or otherwise unknown terms that are to be memorized. Numbers are rationalized by a code of consonants, each representing a given digit, which are combined into a word, or more commonly into a group of words, possessing some relation to the date or formula to be memorized. The meaning of unfamiliar words is made intelligible by means of others of similar orthography and meaning, when their sense is known to us.

182. The Laws of Association.—Two distinct problems are involved in the study of the laws of association, namely, the relation between memory residues that make the recall of one possible through another, and the relations that serve to connect such residues with one another.

With reference to the former question, the simultaneousness of two perceptions in consciousness is the occasion and the condition of the connection between memory residues, but it is not the bond that associates them.

Aristotle already remarked: "When we endeavor to recall, the memory is actuated by reason of its former activity, until the act, succeeding the content we are endeavoring to recall, is brought back into consciousness. Hence, we search our thoughts for something connected with the desired content either in our present or our past experience, or for something similar, contrary or adjacent to it."[6] In these words Aristotle sets up simultaneousness, contiguity, contrast, and similarity as the four laws of association. These relational experiences constitute

[6] *De Memoria et Reminiscentia,* II, 451 B, 16–20.

the psychic bond that joins memory residues with one another and with perceptions. Since relational experiences can take place only on the condition that their objects are in some manner simultaneously present in our consciousness, all associations may be reduced to simultaneity. But not all relations between psychic contents simultaneously experienced are noticed and remembered. The four kinds of relations mentioned above are the preferential relations that associate memory residues and perceptions in such a manner as to make the recall of one member of the relation possible by means of the other.

(1) *Simultaneousness.*—The spontaneous recall of other facts that were perceived at the same time as those voluntarily recalled is one of the commonest experiences of memory. In recounting the vividly remembered scenes of a journey, we may involuntarily recall an entirely irrelevant conversation that took place between our travelling companions as we viewed the landscape. The teacher's explanation of a school classic looms up again when it is re-read in later years. We assure ourselves that we closed the window, because we have a distinct recollection of the draft ceasing.

(2) *Contiguity.*—The recall of a given object often brings with itself the involuntary memory of another object that was near by. The representation of an office building that we frequently pass will be associated with that of a motor car often standing before it, and of persons seen entering the building or coming from it. A friend's book that we have seen in his library recalls other books on the same shelf.

(3) *Contrast.*—Mere contrast is not invariably sufficient to establish associations, but contrasting objects impress themselves easily and deeply on the memory. Homes of wealth and hovels of poverty, examples of virtue and vice, transportation by rail and airplane, joy and sorrow, are contrasting objects likely to recall each other when one of the correlatives is contemplated. This type of associational recall is very frequent in emotional states.

(4) *Similarity.*—Similarity is easily and quickly noticed, and psychic processes are intensified by others similar to them, or identical with them. If the experimenter successively presents to the subject a series of words or pictures in which one member occurs twice, this word or picture will leave a more clear, distinct, and vivid impression than the members viewed only once, even though the identity of the two words or pictures was not recognized. Perceptions are often associated with representations, as in the case of a person whose features remind us of some one we have seen before.

183. Memorizing.—(1) The formation of associations is a gradual process, requiring time and concentration. It begins before the matter to be memorized can be recalled, and continues for a certain period after the work of memorizing has been completed, provided that the mind remains undisturbed and is not engrossed in other work.

(2) The fear of failure, and the consequent haste in memorizing, is an inferiority complex that appreciably reduces the efficiency of memory. In this condition the actual achievement of the subject falls far short of his real ability.

(3) Lengthy material possessing logical connec-

tion is best memorized in unified sections, and the work of memorizing is advantageously distributed over a longer period of time, interspersed with short intervals of rest between the sections. When a long composition is memorized at one sitting, the beginning and end of the material are most faithfully remembered, because they find attention at its best.

(4) The first reading of the matter should be slow and careful, for it is then that the senses form their perceptions of it, and the mind grasps the details of its content. The power of concentration is limited, and therefore the complete understanding and assimilation of the material requires a corresponding period of time.

(5) The matter should be memorized as a unit, the preceding sections being repeated in their natural order when the succeeding ones are being learned. This insures correct sequence and prevents the formation of false associations. Some investigators advocate this procedure even when unconnected material, such as a list of words, is being memorized.

Since the cultivation of an accurate and highly developed memory was even more important for the acquisition of knowledge before the invention of printing, it is not surprising that Aristotle already wrote a treatise *De Memoria et Reminiscentia.* In his commentary on this work, St. Thomas Aquinas gives the following rules for memorizing, which anticipate the modern principles of mnemonics: "From the foregoing exposition we can, in addition, learn four principles that further the cultivation of a good memory and power of recalling. First,

arrange the matter to be remembered into a definite order. Second, concentrate the mind deeply and intently on it. Third, ponder it often, following the order in which it is arranged. Fourth, begin to recall from the beginning of the matter."[7]

184. Dissolution of Associations.—The great majority of associations do not persist indefinitely. (1) The objects they associate lose their individual characteristics in the memory, and only their general marks remain associated and definitely recallable. (2) The association itself is weakened, and the reproduction of the associated object becomes difficult and fragmentary. But inability to recall the associated object does not always indicate the destruction of the associating bond, because the association can often be reëstablished by a much smaller amount of work than that which was expended on its initial formation. Matter that is memorized a second time is retained much longer and more faithfully than when it was first committed to memory.

The rate of forgetting is rapid in earlier, but slow in later stages. Earlier associations of a given object with another may inhibit its ready association with other objects (*genetic inhibition*), and its later association with other objects may weaken its association with the objects with which it was originally associated. Associations are weakened, and often destroyed, if the mind is intensely occupied with other subjects immediately after the formation of the association (*retroactive inhibition*).

185. Association and Recall.—When past experiences are reproduced from their memory residues,

[7] *Opera Omnia*, ed. FRETTÉ, Vol. XXIV (Paris, 1875), p. 284.

they are developed into representations. Because of the psychic connection of these residues with others by means of the associations described in Section 183, the recall of one such residue often entails the concomitant reproduction of others with which it is associated. Since there are multiple associations of memory residues, their associational reproduction likewise is often multiple. The recall of one object is accompanied by the recall of several others associated with it. But the degree of psychic development that these associated residues attain in consciousness varies greatly. Few of the residues associated with one that is directly recalled, are reproduced in the same highly developed form of representation that is accorded to it. Usually they are reproduced only in an imperfect form, and often they merely approach the threshold of consciousness, ready to be recalled, or just beyond recall. Examples of these different degrees of associational reproduction are found in the memories that barely flit for an instant before consciousness, in the recall of a syllable or of the initial letter of a name, or of the generic element of a specific concept, and are in many instances designated as "vague memories." The unerring "instinct," or judgment of a scholar exploring an uncharted domain of science, is largely guided by his imperfectly reproduced past experience and study.

186. Selective Reproduction.—The association of a given memory residue with others does not necessarily imply their reproduction when it is recalled, nor does the concomitant reproduction of other residues together with the one that is directly recalled prove their association. In the case of mul-

tiple association, several factors determine which of the many residues associated with the one directly recalled, will actually be reproduced. (1) Other things being equal, the residue joined by the strongest, the most vivid, or the most familiar association is reproduced. (2) The general direction of mental activity exercises a predominant influence on the reproduction of associated mental residues. A physician will be reminded of matters pertaining to his practice by the indifferent incidents of daily life; a historian, of familiar events in the life of nations. (3) The task on which the mind is engaged for the time being, favors the associational reproduction of the residues whose objects have a bearing on it. Literary reminiscences loom up before the mind when it is engaged in literary topics, but things of a more practical nature come to mind when we prepare for a journey.

187. Non-Associational Reproduction.—(1) Perseveration is the reappearance in consciousness of a representation from which attention has been averted. The memory of a vivid experience persistently intrudes itself into consciousness during working hours, despite repeated efforts to put it out of mind. Perseveration occurs both with regard to pleasant and disagreeable experiences, especially such as recently engaged the attention, and it is favored by fatigue and the cessation of attention. The events of the day follow us into sleep in the form of dreams. The mind continues to occupy itself with objects from which attention has been averted, as in the case of a name whose recall was vainly attempted, and which spontaneously and vividly appears in consciousness after several hours,

during which attention was moving in other channels.

(2) Similarity between a present experience and memory residue probably effects the reproduction of the latter without previous association, and unassociated residues are probably recalled in the same way. Comparisons that are so frequently made between objects never before seen and similar ones that are familiar, appear to prove this opinion, which is not admitted by all investigators.

(3) Other cases of non-associational recall (*e.g.*, certain dreams and mental obsessions) may perhaps be initiated by physiological conditions, such as changes in the composition, temperature, and quantity of blood in the brain.

188. Value of Association.—The power of association, the vast number and greatly diversified character of representations that memory recalls, the various degrees of development in which they appear, and the voluntary direction that can be given to the stream of experiences thus recalled, are a most valuable natural endowment that makes our past experience available as working material for the pursuit of knowledge and the attainment of the practical aims of life.

189. What is Memory?—An object is remembered when it is perceived as a past experience by reason of its reappearance in consciousness in the form of a representation. The act of remembering is not based on any awareness of the process by which memory residues are developed into representations, for this is not a conscious process. On the contrary, these representations are accompanied by the awareness that we formerly experienced them,

and from this awareness we come to know that they are *reproductions* of former experiences.

190. Theories.—The nature of the act of remembering is the final problem to be discussed in the study of memory. Two groups of theories—the one empiristic and the other nativistic—have been put forward in answer to this question. In the empiristic view, a representation is recognized as a past experience of the subject by certain other psychic processes that accompany it by reason of this former experience. According to the nativistic theories, it is recognized by certain intrinsic characteristics.

191. Empiristic Theories.—All experiences, whether first experienced or renewed in memory, appear in themselves as original experiences. But some of them possess secondary characteristics in their relation to the subject, which lead the latter to interpret these characteristics as memory signatures, and hence to consider the experiences possessing them as having formerly been present in its consciousness.

Thus, memory has been explained as based on a feeling, or awareness, that the object remembered is familiar to us. The organism is adapted to stimuli formerly experienced, and their reëxperience gives rise to a feeling of satisfaction. This theory is proposed in various forms by eminent psychologists, such as James and Titchener. A sense of familiarity, or acquaintance, undoubtedly often accompanies memory experience, and it is a valuable secondary signature, but it is rather a concomitant than a constituent of memory.

An object formerly experienced actuates repre-

sentations with which it is associated, and it is for this reason designated as a former experience. Thus, names evoke representations of objects to which they are applied. It is to be considered, however, that in many cases past experiences reproduced in this manner are not recognized as such.

192. Nativistic Theory.—Claparède and others[8] seem to approach nearer to a solution by explaining the acts of memory on the basis of the connection existing between memory representations and the ego. When they are recognized, such representations embody, besides secondary characteristics, the psychic content of the subject's former experiences and a more or less developed representation of the original act of perception. The latter is the primary memory signature.

The transition of the act of perception from its original state (in which it was the subject of the psychic content) to the condition of an object perceived in the form of a representation by immediate recall after perception, is frequent, and therefore familiar to the mind, even in early childhood. This transition is linked with the immediate and fundamental perception of succession, which takes place simultaneously with it, as the earlier instants of the psychic present recede into its later phase, and thence into memory (Section 147). Hence, the residues of the content of perception—and of this act itself, as having been perceived in direct or reflex consciousness—are associated in the same psychic form (namely, a representation) and into a single memory residue, and the mind becomes immediately aware of the character of preterity

[8] See Fröbes, *Lehrbuch d. exp. Psychologie*, II, 176.

attaching to it when these associated residues are reproduced.

In the direct recognition of an object, when it is remembered apparently without the production of a representation, the latter is either actually present but not attended to, or it attains only that initial degree of perceptibility in which it causes a sense of familiarity with the object represented, or a vague awareness that we have perceived it in the past.

The error of asserting the identity of objects that are merely similar but distinct from one another, is an error of judgment, misinterpreting the data of memory by identifying representations with one another, or with perceptions, when their distinguishing marks are unperceived or forgotten. False memory is also caused by the alteration of the reproduced experience, by its association with other experiences, and by the undue influence of secondary memory signatures.

The failure to remember a correctly reproduced representation in memory is caused by the failure to notice the original act of perception, reproduced as a representation simultaneously with its content, or by the failure of the memory to reproduce it in a degree of development sufficient to render it perceptible.

Secondary memory signatures are far from being useless or superfluous. The sense of familiarity with the objects remembered, the ability to use them promptly and correctly, and feelings of agreeableness, satisfaction, and certainty are of great value for the recognition of past experiences. They are often subjectively true memory signatures, but they are not of themselves alone decisive and unerring

motives of a true judgment as to whether or not we have perceived a given object in the past. Many cases of mistaken identity have occurred through the exclusive application of secondary memory signatures.

§ 4. IMAGINATION

193. Nature.—Imagination is the power or combining memory representations, or their parts, independently of the original perceptions and of their position in them. Representations of the imagination differ from those of memory inasmuch as they do not merely reproduce the content of former perceptions, but combine it or parts of it into new cognitional units, to which there need be no corresponding reality. The products of the imagination are not entirely original, since all their constituent elements are derived from former perceptions retained in the memory. The specific function of memory is the reproduction of former perceptions as a part of the subject's own past experience, but memory practically never yields a perfect image of the perception it reproduces. Since representations are acts of a sensory faculty, they differ from thought. Representations are concrete and individual; thought is abstract and spiritual.

The "creative" imagination of artists and scientists is extraordinary and original productive intellectual ability, utilizing images of the imagination as symbols, illustrations, or plastic embodiments of the highest order of thought. On the other hand, the products of the imagination are termed "fantastic" when they are not directed and disciplined by the rational faculties.

194. Influence.—The influence of the imagination on the other activities of the soul may be very great. It may stimulate the intellect to creative work, and become a powerful aid to concentration. It may place noble ideals in plastic form before the intellect and the will, and endow them with a lasting power of attraction. When the imagination is properly guided by the rational faculties, it makes the senses useful servants of man's rational nature, instead of sources of distraction and error. But an uncontrolled and luxuriating imagination may enshroud and enrapture its victim into a world of illusions approaching hallucinations, and estrange him from the true goal of knowledge and endeavor. Intense activity of the imagination reacts on the other faculties by feelings and motor innervations that lead to outward manifestations in the forms of speech and pantomime.

§ 5. DREAMS

195. Psychological Description.— Dreams are caused by peripheral and central sensory stimuli, and by organic sensations and feelings. Their content is largely determined by the experiences, occupations, and conversations preceding sleep.

The relative proportion of representations in sleep varies greatly in different persons. Visual representations were found by several investigators in over 90% of the dreams studied, acoustic representations were somewhat less frequent, while tactile and kinesthetic representations were comparatively rare, and gustatory and olfactory representations were seldom found.

The intensity of representations in dreams is so great as to produce the most vivid hallucinations, and their content shows the most extraordinary deviations from that which is normally caused by the sensory stimuli originating them.

The objects represented in dreams are usually places, less frequently they are persons, and more rarely things. Representations of speech occur in many dreams, and difficulties in finding words and naming objects, as well as meaningless combinations of words and syllables, have often been observed in dreams.

The activity of the mind, and especially that of the will, is greatly diminished in dreams, but it is not altogether absent. Instances are not lacking in which mathematical problems were solved in dreams, conversations were carried on, and physical and moral evils were recognized and met with resolute opposition.

196. Duration.—Many dreams that are crowded with events take place in very brief intervals of time, but in others the succession of representations is no more rapid than the same processes occurring in the state of wakefulness. The sound of a shot may cause the dream of a battle with its varying fortunes, and yet wake the dreamer instantly. The ringing of an alarm clock gave rise to a dream in which the sexton was heard ascending the stairway to the church tower, the bell was seen motionless for a short time, until finally it began to ring.

197. Incoherence.—Logical succession of events is usually lacking in dreams. Disconnected images and incidents succeed one another, and initial and final phases of events are perceived without the

necessary intermediate phases and transitions. Rational judgment is suspended regarding the most bizarre situations and representations occurring in dreams. The most preposterous situations are accepted as true without question and acted on without hesitation. Impossible monsters paralyze us with fright, and fairy scenes transport us with joy. Ludicrous pronouncements are admired as oracles of wisdom, and commonplaces assume a character of prophetic import and are gravely uttered with pompous dignity. The tests of wakefulness are applied in dreams and found verified.

198. Psychoanalysis.—The capricious appearance and combination of representations, the absence of logical sequence, and the lack of critical judgment seem to stamp dream life as the irregular and irresponsible play of memory and imagination devoid of rational purpose and control. The interpretation of dreams in a rational sense, ranging from wildest fantasy to prophetic inspiration, has been attempted from ancient times. The theory of Sigmund Freud, the Viennese psychiatrist, is the most widely known attempt to put the interpretation of dreams on a scientific basis.

According to Freud's view, the fulfillment of inhibited desires is the basis of dreams. The psychiatrist discovers these desires by directing the dreamer to relate his dream and to state whatever associations spontaneously occur to him at random in connection with the objects and incidents of the dream. By this method a single desire, or a group of desires, has often been revealed as the alleged foundation underlying grotesque and absurd dreams.

Dream activity utilizes the experiences of the

wakeful state, and fashions them into the structure of the dream in so far as they can be made to serve this end. But, since the unfulfilled desires of the wakeful state are selfish and often sexual in character, the education of the dreamer has taught him to repress them. This inhibition is still partly operative in dreams in the form of a psychic censorship, which transforms the mental expression of the repressed desires exciting shame into seemingly innocent and often apparently meaningless symbols.

Combination, dislocation, substitution, and inversion are the disguises devised by the mind to express the realization of inhibited desires. Combination consists in unifying several persons possessing common traits, in order thereby indirectly to express another relation. Dislocation serves the same purpose by mentally stressing an unimportant detail of an object. Substitution replaces logical by temporal connections, and puts one person for another. Inversion expresses the opposite of what is intended.

In proof of this theory Freud appeals to children's dreams, in which unfulfilled desires are often realized, to the experiential verification of his interpretations, to the complete solution of the problem they afford, and to the cure of neuroses by diagnosing and treating their symptoms according to his method.

199. Freud's Error.—Freud's theory contains valuable observations, but it does not fulfill the requirements of a scientific explanation of dreams.

(1) There is no proof that the random associations mentioned by the dreamer are regularly operative in his dreams. Moreover, reflection on the dream, in response to the psychiatrist's questions,

actuates multiple associations that will hardly be aroused during the brief duration of the dream.

(2) The theory of psychic disguises is a fiction, and not founded on fact. Since the connection between the dream and the alleged meaning associated with it is an unconscious process, it is unknown to the dreamer, and hence he cannot testify concerning it. In the absence of known associations, he may at most indicate a purely possible connection that may exist between the content of his dream and his psychic acts occurring in the state of wakefulness.

(3) The *libido* is not the fundamental human instinct. This place is to be assigned rather to the desire for self-preservation, or to the will to power.

(4) The alleged parallel with the symptoms of neuroses is non-existent, because in the latter case there is a proved causal connection between the symptoms and the malady. In Freud's explanation of dreams, this connection is merely postulated.

(5) Purely terrorizing dreams without a vestige of inhibited desires are not infrequent. Freud's theory offers no explanation of them.

(6) The psychic censorship excogitating mental disguises would not bring about the fulfillment of inhibited desires, but only an almost obliterating concealment of them even from the dreamer. The logical interpretation of a meaningless dream introduces an extraneous element into it.

200. Psychology of Dreams.—Selfish desires often make their appearance in dreams, and they may cause an emotional mood and coöperate with perseverating processes to effect a certain degree of logical connection in the dream. When there is a conflict between desire and will in a semiconscious

state, and the desire is inhibited or sublimated, this is the effect of moral principles vanquishing the desire, and not the result of a fictitious censorship. The so-called "disguises" are the awkward floundering of memory and imagination deprived of rational guidance. The characteristic properties of dreams—namely, their hallucinatory character, grotesqueness, disconnectedness, and lack of critical judgment—are perhaps the result of the extreme narrowing of consciousness, leaving the dreamer without his accustomed criteria of truth and reality, which are at his disposal in the state of wakefulness, and presenting to him only an isolated group of phenomena.

§ 6. GENERIC REPRESENTATIONS

201. Nature.—Generic representations are de-individualized representations that serve to represent a group or a class of objects in the imagination. They agree with particular, or individual, representations in their general character as sensory images, but differ from them by the omission of the distinguishing marks of individual, concrete objects. Thus, we have generic representations of man, house, box, river, square, green, etc.

202. Formation.—All generic images originate from individual representations. Repeated observation of the same object impresses its prominent characteristics more strongly and distinctly on the senses than its lesser and its obscure details. When it is viewed from different angles and under varied illumination, its general outlines are perceived more clearly, but the multitude of its details leaves only

fleeting impressions in sense and memory. Concentration of the attention on the image intensifies the perception of its outstanding properties. The memory residues and the representations produced from them in the imagination are vivid, clear, and enduring in the case of intense sensations, but correspondingly vague, indistinct, and fleeting when the original sensations are weak. In this way the recall of even a single object perceived effects an image from which many individual marks are absent, and which is in this sense de-individualized.

This representation becomes still more generalized, though always remaining concrete, when a number of similar objects have been perceived and representations of them have been, so to say, superimposed and fused into a unit. In this process the common marks of similar objects are retained in the newly formed representation, and their distinguishing characteristics omitted. Hence, the content of generic representations is meager and schematic, their appearance in imagination and memory is fragmentary and fleeting, and their constituents are fluid and changeable. On account of these conditions they are capable of representing a group or a class of objects, and are in so far generic representations.

§ 7. APPERCEPTION

203. Description.—Apperception connects representations with perceptions by identifying and interpreting the latter, and so incorporating them into the system of representations. Simple cases of apperception may be observed in children interpret-

ing and naming pictures of objects they have previously seen, or identifying things previously described to them. Idiomatic expressions may linger long in the memory without being understood, until their meaning suddenly dawns on the subject, and they become an integral part of his vocabulary by this act of apperception.

Apperception involves memory and association, but differs from both. Memory contributes the representations of words and objects, usually in the form of generic representations, and identifies them as part of the subject's own experience. Apperception organically assimilates a perception into the subject's already organized store of knowledge. Association connects representations and perceptions, so that one evokes the other. The principal function of apperception is the classifying embodiment of new perceptions into the sum total of the subject's knowledge according to definite categories.

The psychic content apperceived consists of words and other symbols and of objects. Apperceptions may be divided into two classes according as they merely identify or classify the psychic content, the latter function being the more important. In the classifying process, especially, apperception is not merely a sensory process, but involves the conceptual analysis of its object. Attention and will prepare and aid the process of apperception by activating and directing the current of associations that are its foundation, and the cognitive acts effecting the assimilation of the object that is being apperceived.

Leibniz, the originator of the doctrine of apperception, understands it as the process in which the soul

becomes conscious of a perception that has until now remained unconscious, by means of its intensification or of an addition acceding to it. In this act the soul also has a reflex consciousness of itself as the subject of the perception. This theory is bound up with Leibniz's doctrine of unconscious perceptions.

Collateral Reading.—Gates, *Elementary Psychology,* Chapters X–XII (Learning); Ladd and Woodworth, *Elements of Physiological Psychology,* Part II, Chapter VIII (Memory and Learning); Pillsbury, *Essentials of Psychology,* Chapter VIII (Memory and Imagination); Seashore, *Introduction to Psychology,* Chapter XXIII (Dreams); Moore, *Dynamic Psychology,* Part V, Chapters I–V (Psychoanalysis); Brueil in *Catholic Encyclopedia,* Supplement I (1922), article *Psychoanalysis.*

Seashore, *Elementary Experiments in Psychology,* Chapters IX–XII; Snow, *Problems in Psychology,* Chapters X–XII.

CHAPTER VIII

THOUGHT

204. Introduction.—Thought is the highest form of cognition. It gives us a rational knowledge of ourselves and of the world, supplies the fundamental principles and concepts of science that enable us to organize the data of experience into a connected whole, and makes it possible for us to establish the practical aims and ideals of life and to determine the ways and means that approach and realize them.

The importance and interest of the processes of thought are paralleled only by their elusiveness when they are subjected to experimental investigation. Sensation can be measured in many respects, the structure of its organs can be studied at length with the aid of minutely accurate instruments, and its functions can be almost indefinitely varied and controlled for the purposes of experiment. But the actual formation of thoughts is a process that defies mathematical measurements and even direct experimental observation. The faculty of thought cannot be examined like the eye or the ear, and the laws of its reaction cannot be calculated by a principle analogous to Weber's formula.

Yet, the application of the experimental methods to mental processes, recent and imperfect though it

is, has yielded important results and confirmed valuable observations made in the past. Where the modern experimental methods are inapplicable, recourse must be had to introspection and to metaphysical inferences based on fully established facts and principles. It is becoming more and more apparent that the ill-repute into which metaphysics fell during the second half of the nineteenth century is merely a transient phase in its history and has passed its climax. The anti-metaphysical orientation is an attitude of mind that was caused by the confusing shock of idealism, by the absorbing interest in experimental science resulting from its unprecedented achievements within little more than the span of a human life, and, last but not least, by bad metaphysics, dogmatic in its methods and prejudiced in its outlook on modern science.

True philosophy will always respect honest doubt and dissent, and, if need be, it will reëxamine, restate, and revise its old and cherished positions in the light of new facts. But neither doubt nor dissent can be suffered to induce a sceptical or a temporizing attitude that veils the face of truth and shuns responsibility.

§ 1. THE PSYCHOLOGY OF CONCEPTS

205. Plato.—Plato formulated the earliest detailed philosophical theory of the origin of intellectual knowledge. According to his view, cognition is the perception of objects by means of images they produce in the soul. Since cognitional images are twofold, sensory and spiritual, there are two kinds of knowledge. Spiritual or intellectual cognition is

based on the existence of supersensible Ideas, which are the archetypes of the material objects constituting the universe. Every Idea is the unique, unchangeable, and imperishable realization of a specific essence. Though it constitutes the ontological essence of the objects of our experience, it is imperceptible by the sensory faculties. Before the soul was united with the body, it possessed independent and separate existence. In this more perfect state, the soul had an intuitive perception of the Ideas by means of spiritual images of them in the intellect. In the present life, during which the soul is imprisoned in the body, the memory continues to retain these spiritual images formed in its original state. When the senses perceive the objects about us, the recall of the spiritual images of the Ideas is occasioned in the form of concepts, and thus we come into possession of actuated intellectual knowledge.[1]

206. Aristotle.—Aristotle's theory on the origin of knowledge is fundamentally related to that of Plato (whose disciple he was for twenty years), but its details show that his keen sense of reality did not desert him in the face of this difficult problem.[2]

According to Aristotle, concepts are spiritual images of the essences of the objects of our experience. These essences are imperceptible by the senses, but the intellect receives spiritual images of them, just as the senses receive sensory images of

[1] St. Augustine adapted Plato's theory to the exigencies of his own thought, and in this essentially modified form it was continued by the Augustinian tradition of Scholasticism.

[2] GEYSER, *Die Erkenntnistheorie des Aristoteles* (1917); JÄGER, *Aristoteles* (1923), 51, 91 sqq., 126.

their material properties, or accidents. The formation of the concept is the psychic act by which the active intellect abstracts the universal image of the essence from its individual sensory image, or fantasm, in the sensory faculty.

The formation of the concept requires a twofold principle, which Aristotle terms the active and the passive intellect (*nous poietikos* and *pathetikos*). The active intellect is a spiritual principle that "illuminates" the individual fantasm, making the universal essence in it perceptible, "abstracts" this essence from the fantasm, and produces the concept or spiritual universal image in the passive intellect.

Aristotle proves the existence of the active and the passive intellect by an argument from analogy, applying to the human soul the hylomorphic theory of the composition of physical substances. He describes the action of the active intellect on the fantasm by comparing it with the action of light on colors. Just as light makes potential colors actual, and therefore perceptible by the senses, so the spiritual "light" of the active intellect renders the potential universal essence in the fantasm actual, and therefore perceptible by the passive intellect.[3]

[3] "But since, as in the whole of nature, to something which serves as matter for each kind (and this is potentially all the members of the kind) there corresponds something else which is the cause or agent because it makes them all, the two being related to one another as art to its material, of necessity these differences must be found also in the soul. And to the one intellect, which answers to this description because it becomes all things, corresponds the other because it makes all things, like a sort of definite quality such as light. For in a manner light too converts colors which are potential into actual colors. And it is this intellect which is separable and impassive and unmixed, being in its essential nature an activity. For that which acts is always superior to that which is acted upon, the cause or principle to the matter. Now, actual knowledge is identical with the thing known, but potential knowledge is prior in

The incompleteness of Aristotle's theory of knowledge led to various interpretations of it by his Greek commentators (Theophrastus, Andronicus of Rhodes, Alexander of Aphrodisia, Themistius), by Averroës and his followers, by the Schoolmen, and by the Alexandrists of the Renaissance.

207. St. Thomas Aquinas.—In the Christian revival of Aristotelianism in the thirteenth century. St. Thomas developed and modified Aristotle's theory of knowledge. He agrees with the Stagirite in describing concepts as psychic images (*similitudines*) of their objects.[4]

They are so designated because they are caused by the objects they represent, and because they convey a knowledge of their object to the mind. However, since concepts are immaterial, they cannot be adequately described in material terms.

St. Thomas further takes over Aristotle's doctrine of the active and passive intellect in the sense of two distinct powers of the soul. This is an essential modification of Aristotle's theory of the active intellect as a divine principle coming from without.[5] According to St. Thomas, the formation of the concept is effected by the coöperation of the active intellect and the fantasm, acting as two essentially

time in the individual, and yet not universally prior in time. But this intellect has no intermittence in its thought. It is, however, only when separated that it is its true self, and this, its essential nature, alone is immortal and eternal. But we do not remember because this is impassive, while the intellect which can be affected is perishable and without this does not think at all.'' ARISTOTLE, *De Anima,* III, 5, ed. HICKS (1907), 134, 498–510. Cf. GEYSER, *Die Erkenntnistheorie des Aristoteles* (1917), 254–77.

[4] It is hardly necessary to remark that St. Thomas does not understand psychic images as pictures.

[5] ARISTOTLE, *De Generatione et Corruptione,* II, 3, 736 b, 27 sq.; *De Anima,* III, 5, 430 a, 17.

subordinated causes, the intellect being the principal and the fantasm the instrumental cause.[6]

The active intellect illuminates [7] the fantasm, and so becomes able to abstract from it the *species intelligibilis*—the cognitional determinant, in Cardinal Mercier's happy phrase. The act of abstraction is the mental distinction of the universal essence from its individualizing marks. This cognitional determinant is received into the passive intellect, which forms the concept by being informed by it, and thus perceiving it. Thus the fundamental act of intellectual cognition takes place.[8]

The passive intellect is not purely passive. Once it has formed the concept, it acts on it in many ways, analyzing it, defining it, combining its elements with other concepts or their elements, and forming judgments and making inferences on the basis of these acts.[9]

208. St. Thomas does not contend that a single act of abstraction necessarily, or even usually, yields a perfect knowledge of the object. The result of the act of abstraction depends on the perfection of the fantasm, the power of the individual active intellect, and the ability of the passive intellect to analyze and combine the data it receives. For a scien-

[6] For the Scholastic doctrine of the essential subordination of causes see COFFEY, *Ontology* (1914), 372–75; REMER, *Summa Prælectionum Philosophiæ Scholasticæ*, II (1912), 338, No. 10. On the instrumental cause in general, *ibid.*, I, 370–372, or GREDT, *Elementa Philosophiæ Aristotelico-Thomisticæ*, I (1921), 407–09.

[7] GUILLET, *La "Lumière Intellectuelle" d'après Saint Thomas* in *Archives d'histoire doctrinale et littéraire du Moyen-Age*, II (1927), 79–88.

[8] For the coöperation of the cognitional faculties in the formation of the concept, see ST. THOMAS, *De Veritate*, Q. x, art. 6, ad 7. On illumination see *Summa Theologica*, I, Q. lxxxv, art. 1, ad 4. On the passive intellect see *ibid.*, I, Q. lxxxiv, art. 7.

[9] *Summa Theologica*, I, Q. lxxxv, art. 2, ad 3.

tific knowledge of things, St. Thomas requires a study of their properties and activities.[10] "Experiment" and "induction" are essential for a scientific knowledge of physical objects.[11]

209. The elaboration of empiric concepts by the mental activities already mentioned opens entirely new fields of knowledge. By means of these processes and their constant control in the light of experience, such important concepts as substance, cause, soul, and God are formed.[12]

210. Experimental Investigations.—The ancient distinction between concepts on the one hand and sensations and representations on the other has been confirmed by the experimental study of thought. Concepts predominate over representations, and are everywhere superior to them. This is the most important result of the experimental investigation of thought. Representations of words and objects are secondary elements in the process of thought. When the mind is engaged in a train of thought, the representations accompanying it are fragmentary and fleeting, they fail to keep pace with its progress, and the advance of thought outstrips them to such an extent that they are felt as retarding trammels. Delicate shades of thought that are clearly perceived often find but imperfect expression, even after a valiant struggle with the most pliant vehicle that language affords. Outward symbols of thought (such as writing and signs) and their psychic repre-

[10] *Ibid.*, I, Q. xiii, art. 8.

[11] *Commentarius in Lib. I Posteriorum Analyticorum*, lect. xxxix sq.; *in Lib. II*, lect. xvi and xx; *Opera Omnia*, ed. Fretté, Vol. XXII, pp. 177, 218, 277, 289 sq.

[12] On the concept of substance, see *Summa Contra Gentiles*, I, xxv, § Sed ad hoc. On the concept of God see *Summa Theol.*, I, Q. lxxxiv, art. 7, ad 3; *Summa Contra Gentiles*, I, xiv, § Est autem via.

sentations play only a secondary part from the very beginning of a child's intellectual life, in which the concepts represented by these signs must be formed by the mind's own independent effort before the symbolic meaning of these signs can be understood.

211. But since the processes of thought are for the most part relational experiences, the chief value of representations in this connection lies in their multiple associations, which appear, often only dimly but yet surely perceived, as progressive or regressive streams of psychic connections, supplying mental perspectives and bearings by pointing out the origins and consequences of the thoughts that course through the mind at a given moment.

Relational experiences, including both the relating act and the relating concept, are especially useful for the study of the difference between thought and sensory cognition. Relations are usually general, or universal, and therefore transferable (applicable) to an indefinite number of individuals; but sensations and representations are concrete and individual. Even generic images or representations are general only in so far as they omit certain individual marks, while retaining other concrete characters either as fixed or as fluctuating constituents.

212. The development of concepts proceeds from the general to the particular. The experimental proof of this assertion consists in presenting a series of images to the subject in rapid succession, and directing him to describe those that recur. The recurrence of a figure is noticed even before its identification is possible. In succeeding presentations of the same series, general conceptual cate-

gories (such as symmetry or curved lines) are formed before any part of the recurring figure has been definitely perceived.

213. Experiments on the recall of visual images have shown that concepts are much better remembered than representations. The concepts formed from visual images may be recalled after the representations have been quite forgotten; and, when the latter are present, they are corrected according to the corresponding concepts. Concepts are also far less likely to become confused than representations. Memory may be accurate though representations are weak, and defective despite their vividness.

214. In a sequence of ideas, thought changes and advances more rapidly than representations. Hence, the processes of thought coöperate with representations in various ways. Images serve to arrest and steady thoughts, to intensify and fix them. They are evoked when thought becomes vague and halting in order to accelerate its progress and to clarify it. Thoughts and images are often so intimately associated that they appear to be fused into a unit. A small group of images is often utilized as a symbolical abbreviation of an extended process of thought, especially in abstract and metaphysical subjects.

215. The fusion of auditory representations (such as arbitrary names) with concepts passes through several distinct processes. In the first stage, several images are likely to appear on the mention of the arbitrary name, and the correct image may be recognized with certainty as having been presented together with the picture symbolizing the concept,

but the name is not yet perceived as signifying the concept. In the second stage, there is an awareness that the name signifies the object, and their relation is recognized. In the third stage, the significance of the name in the mind precedes the object shown as a symbol of the concept, and the explanation of the object adds nothing to the meaning of the arbitrary name. In the final stage, the name is the constant subject of the meaning associated with it, and the two are difficult to separate. Now the representation of the object no longer appears when the name is mentioned. If it is voluntarily evoked in memory, it may be incomplete and partly false, and in this case it is corrected according to the concept. This experiment affords an excellent illustration of the subordination of representations to concepts. Concepts of individual objects are invariably accompanied by images—"fantasms" in Scholastic parlance—but general concepts lack them.

216. The experimental methods of psychological research have been successfully applied in the investigation of certain instances of the process of abstraction, which is the mental separation of a conceptual element, incapable of existing for itself, from a total psychic content in order to embody it in another process of thought (*e.g.*, as the subject or predicate of a judgment, or as an element of another concept). In this sense, positive abstraction differs from merely negative abstraction, in which the attention is directed to one conceptual element, while the remainder of the total psychic content is perceived, but not attended to.

A carefully controlled investigation of the perception (abstraction) of identity, independently con-

ducted by different psychologists,[13] has shown that this act is distinct from the perception of the objects between which this relation was recognized. For the perception of one of the objects occasionally passed unnoticed, sometimes its distinct perception followed after that of relation, and in other instances both objects were perceived, but their identity remained unnoticed, or was only afterwards perceived despite the concentration of attention in favorable conditions and the primary intention to observe identity. The separability of the two acts —namely, the perception of the two objects and of the relation existing between them—proves their distinction and their difference from one another.

217. Relational perception is a supersensible or spiritual act. For relations such as identity, similarity, and difference, exist between non-sensible objects (*e.g.*, between general concepts and numbers). Furthermore, two sounds may be compared and found to differ from each other; yet, the perception of "difference" has none of the characteristics of sound, and it may be applied without modification to other categories of objects, such as green and blue. It possesses none of the properties of any sensation, and hence it is not the act of any sensory faculty. The senses distinguish different objects (*e.g.*, a bitter berry from a loud sound), but they have no perception of difference as such. They perceive the concrete foundation of relational experiences but the latter cannot be assigned to any sense,

[13] GRÜNBAUM, *Über die Abstraktion der Gleichheit* (1908); IDEM, *Untersuchungen über die Funktionen des Denkens und des Gedachtnisses* (1917); BÜHLER, *Die Gestaltwahrnehmungen* (1913); LINDWORSKY, *Zur Psychologie der Begriffe* (1919). Cf. FRÖBES, *Lehrbuch d. exp. Psychologie,* II (1920), 191.

for the ear cannot perceive bitterness and the sense of taste cannot become aware of sound. Since the objects to be compared for the relational experience must be perceived together in one cognitive faculty in order to institute a comparison between them, this faculty must be sought outside the realm of the senses.

Relational acts and concepts are not associations, for the latter merely furnish the material for the former; and, moreover, relational concepts exist without the presence of the second member required for every association, and even without being attached to any objects whatever. Finally, two objects may give rise to a relational experience, although no association in the specific sense exists between them.

218. Direct Empiric Concepts.—Whatever direct knowledge of the nature and the formation of concepts it is possible to obtain, can be got only through the experience of their formation, the observation of their properties, and the determination of their significance in ourselves and others. Since concepts are derived from sensations, the psychic experience of the production of concepts is not primarily the recall and observation of finished concepts perfected by countless acts of the mind in the past, but rather the observation of new concepts in the process of becoming and elaboration.

219. Generally speaking, empiric concepts are formed by the direct perception of objects (*i.e.*, the perception of objects in themselves), not by the inductive abstraction of common marks through the observation of many similar objects. The latter process, however, is employed for the formation of specific concepts of natural objects, but the prim-

itive concepts elaborated in this manner are direct perceptions.

The existence of the object and its presence in our consciousness are required for its direct perception. If an object were no longer existing, it could be known only indirectly through inference or report. If it were not present to our consciousness, it could not actuate the cognitional faculties to posit their acts. Two great classes of objects can be known by direct perception, the physical world about us and the psychic states and acts of the soul. The existence and nature of the soul are known only through inferences based on directly perceived psychic activities.

220. Objects directly perceived exist only as individuals, but they are not by their nature unique. An area of blue situated in a given section of the sky may be exactly duplicated in another sector and at another time. In a pine forest the characteristic properties of the pine are perceived in every tree. Hence, when the character of "blue" or of "pine" is alone perceived by the mind, its capacity for being realized in many objects in a perfectly identical manner shows that it is a universal or general content of consciousness—*i.e.*, a cognitional content capable of extramental realization in many objects by individual determination through the ontological characters that make each individual such as it is, in distinction from all other individuals of the same kind, and in opposition to the same nature common to all of them. But, when a universal cognitional content is realized in different objects outside the mind, it does not exist in them as a separate and independent part. It consists of

various characters or marks that can be distinguished in the individual—oftentimes only through long-continued efforts—without being separable from it in reality, and without possessing existence independently from it. The act of abstraction, by which the concept is formed, consists in the perception of these general characters in the object, and in recognizing and understanding them as such in distinction from its individual marks.

The perception of the universal, as concretely realized in the individual, may be clear and certain or dim and dubious. It may be accomplished by a single act of the intellect, or it may require many intensive acts extending over a long period of time. The final result may be a true scientific concept, or it may hardly be an advance over the crude initial conception.

221. The formation of generic representations is an important, though not essential act preparing the abstraction of the concept, since it omits only certain individualizing marks from sensory perceptions, and reduces them to a fluctuating state (Section 202).

Relational experiences are from early childhood among the most frequent acts by which concepts are formed. Children notice the differences between objects earlier and more extensively than similarities. These acts, resulting from comparisons, imply the gradual formation of numerous concepts by the mental distinction between common and individual characters, and lead to predications and inferences that give rise to still further concepts. The material so given to the intellect is finally consolidated in a relatively stable form by associating names

with the concepts thus far acquired, and so making them more readily available in memory, until they are further developed—and, if need be, rectified—as experience widens and the intellect matures.

From the foregoing exposition it will be seen that the acts of abstraction are nothing else but the mental distinction by the intellect of general or common from individual characters in the objects of thought.

222. Concepts cannot be identified with sensory perceptions, for the general or universal content of the concept puts it into a distinct category. All objects of sensory perception are physical and individual, for on the one hand an organic faculty can perceive only material objects, and on the other hand these objects can exist only as individuals. The eye can see only this green, existing here and now, but the intellect perceives green in general or color in general, because we possess these concepts and apply them indiscriminately and identically to all objects in which they are realized. Now, the perception of green in general or color in general cannot be a sensory act, because these objects of thought are neither physical nor individual. Color as such and green as such cannot exist in nature. Yet they are perceived in themselves, and therefore present to consciousness in themselves, mentally isolated from concrete and individual sensory perceptions by acts of thought. Hence, these acts are non-sensory acts of cognition.

223. Inductive Empiric Concepts.—Direct and immediate concepts are formed by a mental process of analysis and distinction, which is the abstraction of the universal or general cognitional content from

the concrete and individual content of sensory perception. The data supplied by these two processes of cognition are utilized by the intellect to form inductive empiric concepts by a process of synthesis.

In one mode of synthesis, empiric concepts are combined into new units by reason of the relations existing between them. In this manner the concepts of gravitation, chemical affinity, import, war, color, sum, fraction, etc., are formed. The formation of these concepts is a complex process, involving the use, not only of immediate empiric concepts, but of many judgments and inferences, because it implies the comprehension of their numerous constituent concepts and of their relations to one another. The synthetic concepts so formed are perfect or deficient, scientific or popular, in proportion to the subject's comprehension of their import. Hence, a scientific definition merely committed to memory is not necessarily evidence of the presence of the corresponding concept.

Another mode of synthesis yields the specific concepts of natural objects or of their classes. These concepts combine direct empiric concepts for the expression of the essential characteristics of their objects, omitting those that are merely adventitious. In distinguishing essential from adventitious characters, the mind is guided by the relations discovered, not between abstract concepts as in the first mode of synthesis, but between the realities themselves, as perceived in the objects the mind is seeking to understand. Inductive and deductive reasoning constantly controls the inclusion of the characters sought into the concept, and the exclusion of others from it. The methods of modern science

have been conspicuously successful in directing the mind in the formation of inductive empiric concepts.

224. Transcendental Concepts.—Since ideas are not innate, all concepts are ultimately derived from experience. But the experiential foundation is not the same for all of them. Immediate and inductive empiric concepts express the nature, properties, and relations found in the objects of our experience. Transcendental concepts, on the other hand, designate objects, properties, and relations that are partly or entirely beyond the domain of experience.

Abstractive transcendental concepts are derived from the objects of our experience, but they are by their nature such that, if there are objects which are by their nature removed from the domain of human experience, these concepts are applicable also to them.[14] If there are supersensible beings, the concepts of simplicity or composition, unity or multiplicity, contingence or necessity, substance or accident, etc., are applicable to them, since these properties are not by their nature restricted to corporeal beings, but are properties of all realities as such.

Purely transcendental concepts designate objects that are by their nature beyond human experience—*e.g.,* substance, cause, soul, God. This group of transcendental concepts is formed by the application of certain experiential relations to empiric data and concepts, resulting in a mediate and indirect knowledge of certain supersensible objects. Similarity, difference, identity, causality, and purpose are among the relations utilized for the formation of purely transcendental concepts. The knowledge

[14] The existence and nature of the supersensible world and the objective validity of transcendental concepts are not psychological problems. They are studied in general and special metaphysics.

acquired by this process of synthesis is always inadequate, abstract, and analogous, because it comprises only what these empiric concepts and relations reveal of supersensible objects, does not give the mind an immediate perception of the things thus indirectly known, and fails to manifest them as they are in themselves.

Purely transcendental concepts must be carefully distinguished from imaginative transcendental concepts. In the formation of the former class, the synthetic combination of their constituent characters by the mind is determined solely by the objectively valid principles of logic and metaphysics, and the mind is necessitated by them. Imaginative transcendental concepts, on the contrary, are the products of the creative imagination, of fancy, or of caprice. Their objects are beyond the range of experience, because the formation of these concepts is not guided by objective principles. Hence, they are mere fictions of the mind.

225. **The Active and the Passive Intellect.**—Aristotle's doctrine of the active and passive intellect, as developed by St. Thomas, is substantially borne out by the study of the activity of the mind in the formation of concepts. The intellect is a passive faculty in so far as it does not produce concepts of itself alone by a creative process, but derives them from sensory perception by the process of abstraction, receiving them passively in itself. But the intellect is also an active faculty in so far as it distinguishes the general or universal characters in the concrete and individual perception, and combines them in many ways by analysis and synthesis. The formulation of purely transcendental concepts

is the highest achievement of the intellect in the fundamental rational process of ideation.

§ 2. THE PSYCHOLOGY OF JUDGMENT

226. Nature.—Psychologically considered, judgment is the purely mental expression of the relation of truth or error between objects of thought. Very early in its natural development, and apart from all scientific and logical training, the intellect spontaneously begins to make assertions concerning the objects of its thought, and it usually assents to these assertions as true. Judgment is essentially a relational act, for an assertion necessarily predicates something about something. The relation predicated in judgment may be positive, negative, existential, identical, qualitative, connective, etc. The object of thought that is the subject of the predication may be an individual, real or imaginary object, a psychic state, a generic representation, etc. The act of judgment gives expression to an objective state of things obtaining between its elements.

227. Judgment and Language.—Vocal and mental speech is not essential to judgment. Many judgments are accorded verbal expression, and many others that are given inward or outward utterance are not made in the form of predications—as, for example, "Well!" "Oh!" "What!" Judgments may also be expressed by a look, a gesture of the hand, or a shrug of the shoulders. But the verbal expression of a judgment, whether outward or inward, often contributes to clearness, and is a powerful aid to memory and to accurate recall.

The various perceptual antecedents of judgments

—such as sensation, ideation, and inference—and their subsequent expression in outward or inward speech may be so rapid and spontaneous, and so intimately fused with judgment in the subject's actual experience, that their succession passes unobserved, and their distinction remains unnoticed. Yet, the reality and integrity of judgment is in no way affected if these preparatory and complementary acts are not, or not clearly, perceived. The associative actuation of complete verbal predication by memory may also occur simultaneously with perception, but the act of judgment is not necessarily posited in such cases. Such predications are logical, but not psychological judgments.

228. **Judgment and Assent.**—Assent to the relation expressed is not essential to judgment. An attentive perusal of the proposition, "intertonic *gli* or *glio* became *i*," may reveal its meaning, and raise the question as to its truth or error, but it does not necessarily involve any attitude of the intellect, the will, or the emotions. The intellect may remain quite neutral, merely realizing that the predication is either true or false, without deciding in favor of either alternative. Yet, this act of the intellect is a true judgment, because it perceives the expressed relation as representing a state of things, and includes the awareness of the truth or falsity of the predication. If the latter element were lacking, there would be no judgment, but a mere sequence or an association of words or concepts. When the mind assents to the relation expressed by the predication, the act of assent is distinct from that of judgment, though it is not so discerned. Judgment, therefore, differs from association by the exclusion

of the awareness of truth or error, and of the reference to a state of things.

229. Assent and Evidence.—Intellectual acts of attitude toward the elements of truth or error in judgment are so spontaneously and uniformly posited with the act of judgment that they are, though not essential, yet an integral part of it. The intellect's attitude toward judgment has the form of motivated assent to it as true, or of its rejection as false. The motives of assent may proceed from the intellect, the will, or the emotions.

Evidence, the chief intellectual motive of assent, consists in the awareness that one has an immediate perception of a state of things. It is not the only motive that excludes doubt and possesses logical value. An object of thought is evident when it is actually present in itself to the intellect, and not merely known indirectly through another object.

230. Evidence, in the sense defined, is a psychological state of frequent occurrence. If two objects are compared, the mind possesses an actual perception of their distinction from each other, and this condition of their being distinct from each other is in itself present to the mind. The relation of distinction is not introduced as an extraneous element into the objects of thought through the mind's act of distinguishing them from each other. The mind posits this act because it finds the distinction already existing in the objects, and it merely expresses this objective state of things by means of the act of judgment. If the relation of distinction were a subjective element introduced into the reality in question by the mind, it should be equally possible to introduce other relations—such as identity and

causality—into the same objective state of things. The impossibility of doing so shows that the perception of distinction is determined by the object, and is not a subjective construction of the mind, erroneously introduced into it. The objective origin of the perception of distinction is further evinced by the observation that, in cases where we are unable to perceive the distinction between two objects with certainty because of their minuteness or proximity, we are clearly aware that our perception is failing us, and we experience a feeling of uncertainty in making a categorical predication concerning the distinction between the objects in question.

231. Evidence is experienced in the perception of concepts, judgments, and inferences, as well as in sensory cognition. No evidence can be more cogent than that presented in certain intellectual perceptions—*e.g.,* that two plus two equal four, that the whole is greater than the part, or that one is thinking. The evidence of such judgments is, if possible, even more convincing than that of sense experience. But, in order that these judgments may be truly evident to the cognizing subject, it is necessary, not only that their content be objectively evident in itself, but also that the subject experience this evidence, and possess a clear and distinct comprehension, actually present in consciousness, of all concepts entering into the judgments in question. When these conditions are not fulfilled, the psychological state of evidence does not exist. Various substitutes of merely secondary value are then evoked to form convictions and to yield certitude. As a consequence, doubt arises, the mind wavers, and assent becomes hesitating. Thus, a sceptical attitude is prepared,

and, inveigled in the toils of these insufficient motives of assent, more than one investigator has mistakenly denied the existence of evidence in principle.

232. The existence of the psychic state of evidence has erroneously been questioned with regard to judgments in which it is not readily perceptible by an untrained mind. The sceptics who take this attitude often overlook the fact that concepts and the evident relations existing between them are supersensible, and that, consequently, no investigation limited exclusively to sensations and representations will manifest such relations.

The existence of evidence as such is also denied by reason of a general sceptical attitude that is merely dogmatic. This attitude of mind fails to establish its own principle and to consider clear cases of evident relations.

233. **Other Motives of Assent.**—Assent coincides with the experience of evidence when the intellect has an immediate perception of an objective state of things. But, since immediately evident judgments are comparatively rare, assent is often based on other motives, such as will, expectation, fear, analogy, and "intuition."

Assent is rarely founded solely on the will that a judgment be true. It may be grounded on this motive when rational motives of assent are unavailable, and when there is at the same time a practical need to form a decision. But in these cases assent is usually based, at least partly, on motives of probability or of expectation. When the command of the will is the primary motive of assent, this condition is often recognizable by the summary rejection of rational motives that seem to militate against the

judgment to which assent has been given, and by the forcible removal from consideration of doubts as to the truth of the judgment.

Assent is more frequently based on a "feeling" of satisfaction caused by judgments that agree with our hopes and expectations, with prejudices and preferences, and with former experiences and present hypotheses. The same influence of emotion on assent may result from the symbolic interpretation of sensory representations, from vivid or sustained imaginations, and from multiple associations between representations and concepts.

Non-evidential motives of assent may be of great value in suggesting working hypotheses, new combinations and interpretations of scientific and literary material, and fresh view-points of trite and familiar subjects. An unerring feeling guides the literary artist in the choice of diction and the development of plot, and a kindred intuition directs the scholar's interpretation of literature. A fine feeling for style and vocabulary may detect interpolations and spurious writings, and identify anonymous fragments.

§ 3. THE PSYCHOLOGY OF INFERENCE

234. Discursive Thought.—Many concepts and judgments formed by the mind are not obtained by the immediate perception of their object, but are derived from others previously acquired in this manner. Derivative concepts and judgments in their turn become the foundation of further derivations. The mental process of obtaining new concepts and judgments from those already in the possession of the intellect is termed inference. When

the derivation of one judgment from others gives us the certainty that the derived judgment is true, the process of inference is termed proof or demonstration. Proof is always inference, but, when inference is faulty and therefore does not evince the truth of the judgment derived through its instrumentality, it is not proof.

235. Natural Inference and Evidence.—Since the observation and description of concepts and judgments—the elements entering into the process of inference—is a difficult task, the psychological analysis of inference, the most complex activity of the intellect, is fraught with still greater difficulties. From a logical point of view, the syllogism is the simplest form of inference. But the natural inferential acts of the untrained mind do not take place after the manner of formal syllogisms. Some elements of the latter may be absent in natural reasoning, the logical order of the propositions may be changed, there may be no actual experience of the process of inference, and the mind may make inferences without distinguishing or even noticing their constituent elements. The intellect may posit a series of judgments that in themselves are a true inference, without perceiving their inferential connection. In this case the mind forms a group of judgments, but it does not go through a process of reasoning, because it fails to derive one judgment from another.

236. The Syllogism.—Syllogistic inference is psychologically characterized by the appearance of the conclusion in consciousness, the awareness of the certainty or doubtfulness of the inference, and of the truth or error of the conclusion. The conclusion

of the syllogism may appear in the mind by way of anticipation before the second premise has been completely assimilated. When the conclusion is formed in the mind after the premises have been fully comprehended, it is expressed in a proposition. This is the most perfect development of the conclusion, which, however, may also remain in more rudimentary stages, either without definite formulation in language, or merely as a direction of thought.

237. The illative act, or the active experiential relation of the concepts entering into the conclusion, is the essential part of the process of inference. When this connection between the premises and the conclusion is not perceived in a logically valid syllogism, there is no true inference, but merely a successive perception of judgments. On the other hand, when a logical connection between the antecedent and the consequent is lacking, but is falsely thought to be perceived, there is a subjective inference, because a conscious inferential relation is experienced.

238. Inference is accompanied by the awareness that the conclusion follows from the premises with certainty, or with more or less probability, as the case may be. The inferential act may possess a further concomitant in the form of the conviction of the truth or the correctness of the conclusion. This persuasion may be based on the evidence of the inferential relation, but it may also be quite independent of it if the conclusion is previously known from other sources to be true. The conviction of the truth of the conclusion may, in case it is independent of the inference in question, react on

the awareness that the conclusion follows from the premises by intensifying it, or even by causing it, if it is not already present. Similarly, the conviction that the conclusion is false in itself may cast doubt on the apparent certainty with which it seems to follow from the premises.

238. Experimental Investigation of Inference.—If the mind has not been trained in logic or scientific method, inferences are not made in the form of syllogisms. The mind proceeds from relations perceived in particular judgments rather than from universal propositions, approaches the conclusion by tentative judgments inserted into the general direction of thought, and revises the result by comparing it with its previous experience and knowledge. Judgments are considered inferential, when they express previously known true relations between concepts, and necessarily follow from judgments already formed. Hence, there is no specific difference between syllogistic and natural inference. In both cases the essential process of inference consists in the perception of a new relation on the basis of the relations asserted in the premises, for it takes place only when the premises are simultaneously present in consciousness.

240. Since inference is a perception, it is a psychic activity, not a purely passive process. However, it possesses distinctly passive aspects in the evocation of concepts and representations from memory that suggest possible conclusions, when the antecedents are given. In some instances, the mind accepts the conclusions thus suggested by association without questioning their correctness, but in others it investigates the logical sequence before

assenting to the conclusion. In every case the perception of a new relation, originating the judgment that forms the conclusion, is the active element in inference.

241. In the natural reasoning of the untrained mind, the premises are not vividly perceived as the ground of the conclusion. There is a distinct awareness of the relation of the content of the premises to that of the conclusion, but not of the logical dependence of the inferred judgment from the antecedent.

The fundamental logical principles of inference are not the conscious basis of the natural reasoning process taking place in everyday life. Children are able to make inferences long before they are capable of making practical use of these principles, and adults are unaware of being guided by them.

The natural tendency of the intellect to attain a knowledge of truth is manifest in its illative acts. Only such premises as are considered to be true are made the premises of natural reasoning, and the desire that the conclusion may be a judgment which can be accepted as true, is present in the soul. This tendency appears also in the experimental investigation of the psychology of inference, in which the wish appears in consciousness that the elements of the reasoning process may be found true, and a feeling of satisfaction accompanies the perception that the conclusion is evident.

242. Nature of Inference.—Inference forms a new judgment on the basis of previous judgments. Only those judgments from which inferences can be drawn, are the foundation of an illative act. These judgments express an objective state of things, not

a capricious combination of concepts, and they are present in consciousness as relational perceptions. Hence, inference may be defined as the psychic act of deriving a new relational perception or judgment from similar perceptions previously acquired.

243. Objective Foundation of Inference.—Because of the absence of the general principles of logic from consciousness during the process of inference, this activity has been explained as a natural law of the mind, analogous to a biological formula or a chemical law. According to this view of our mental processes, they are merely psychic modes of activity, and their results are as foreign to the external world and the realm of metaphysics as the principles of philology are to the science of chemistry. Hence, the contention is made that the principles of logic are merely psychological laws according to which the mind functions, and they are valid only in the mind itself. Inferences, therefore, may be formally correct and consequent thought, but never valid predications about any objective reality.

244. Mind and Object as Cognitional Factors.—All activities of the soul, sensory as well as rational, are evidently founded on its nature, from which they proceed. Only because the soul possesses cognitional powers are we enabled to perceive objects, to recall them, to form ideas, and to apprehend relations existing between them through the acts of judgment and inference.

But the activities of the mind are not performed independently of their objects, like the laws of chemistry operate independently of the sphere of history and philology. The objects of thought in many ways condition its exercise. When the mind

posits relational acts in judgment and inference, it does not create these relations, but perceives them existing in the data presented to it. In its content the process of thought is governed by the laws of its objects. The mind may refuse to acknowledge these laws, and choose to be a law unto itself both in theory and in practice; but, by so dissociating itself from reality, it forfeits all claim to correct thought and true judgment. The laws governing the content of judgment and inference are those that govern its objects, not those that arise from the nature and constitution of the soul.

245. Psychic Genesis of Inference.—Our earliest experiences are those by which objects are compared and distinguished from one another. These acts originate generic representations and general concepts in the mind of the child. Practical needs and association with other persons direct the child's mind to other objects, the concepts and representations of which are apperceived into its small store of concepts and representations previously acquired. The apperceptive acts are judgments, and, in so far as they are sufficiently motivated, they possess objective validity. These are among the first, if not the very first, acts of judgment performed by the child's mind.

Through errors of judgment the child obtains a vague awareness of truth, as the agreement of judgment with reality, and of the nature of judgment itself, as the variable combination of concepts in relational experiences. This perception of truth and of the act of judgment is not formulated into propositions or definitions, but remains for the

time being a concomitant perception of a factual character attaching to certain psychic acts.

Primitive minds may remain in this early stage of psychic development throughout life, but even they will in early years be led to make inferences when practical conditions demand proofs of statements made by themselves or heard from others. Thus, thought in the form of inferential experience is controlled and guided by its object. Since the general principles of logic consist in the relation of these objects to the judgments making predications about them, even untrained and primitive minds possess a virtual knowledge of logical principles, and are thus factually enabled to determine at least in a rudimentary manner the truth and falsity of judgment and inference.

246. Functions of Mind and Object in Inference. —The objects of thought do not effect the acts of comparison and the perception of difference or of agreement, nor does the mind create them by applying extraneous laws to its object. The foundation of these acts exists in the objects of thought in so far as each of them has a nature and properties peculiar to itself. Hence, every object acts on the mind in a manner corresponding to its own nature, and produces a distinct concept in the mind. By the act of comparison, the mind views different objects together, and recognizes the differences already existing between them. When the difference between these objects is further asserted in the form of a judgment, it is this objective difference, as found by the mind to be preëxisting in the objects and as having caused different concepts of them,

that the mind perceives to be correctly expressed by the act of judgment. The object is the standard according to which the judgment is formed. Not intrinsic, psychic necessity in psychic activity, but objectively motivated correctness determines the definite acceptance of the judgment, and the absence of rational motives brings about the rejection of judgments already formed.

247. The influence of the object of judgment lies in the fact that it gives rise to the concepts that are the elements of every judgment, and that the mind conforms its judgment to the object as perceived. In particular judgments the mind's act is conformed to an individual object. But, when the mind possesses a knowledge of the general principles of logic, they are for it a scientific standard in the formation of judgments and inferences, ready to be applied to every process of this nature, aiding in the selective actuation of memory residues, and giving definite direction to the mind in searching out relations existing between objects of thought.

248. Logic and Inference.—A knowledge of the principles of logic is not required for judgment and inference as such, but the objective certainty and truth of these acts depend on the validity of these principles, since they are implied in all judgments and inferences. Subjective certainty may be founded on a variety of motives, and it does not presuppose the knowledge of logic; but this knowledge is indispensable for definitive, objective certitude, if this state of mind is to be a fully reasoned attitude from its foundations up, and if it is to be secure against all objectively motivated doubt.

The principles of logic, which exercise such absolute dominion over the formation of judgments and inferences, are not functional laws of mental activity, but constitute the impossibility of actually experiencing reality otherwise than it is. Psychologically considered, the principle of contradiction, for example, means that we cannot experience an existing and perceived relation as non-existent and unperceived. The psychological impossibility of such experience is based on the fact that the simultaneous realization of the content of contradictory judgments is ontologically impossible.

Collateral Reading.—MERCIER, *Manual of Modern Scholastic Philosophy,* Vol. I, pp. 238–63; MAHER, *Psychology,* Chapters XII–XV; PYNE, *The Mind,* pp. 263–323.

CHAPTER IX

APPETITION

§ 1. FEELING

249. Sense Feelings.—When a sensory stimulus is conducted from the organ to the brain, a certain amount of nerve energy and substance, though minute in quantity, is consumed, and waste matter and the toxins of fatigue are produced. This condition in its turn has a physiological repercussion in the vasomotor and the nutrient structures connected with the peripheral organs. In the case of normal sensations that are not too long continued, this reaction is not great, but, when a sensation produces strain through its intensity or long duration or when a pathological condition is present in the organ, organic sensations result which are accompanied by feelings of pain—nature's danger signal. Normal sensations may be accompanied likewise by feelings of pleasure, especially when their objects are eminently conducive to the welfare of the organism. Besides feelings resulting from the physiological irradiation of sensations over the organism, certain sensations give rise to feelings of pleasure or unpleasure.

Feelings and sensations are often so intimately connected that they remain undistinguished in consciousness; and when experiences, embodying both

of these elements, are subjected to analysis, the intensity with which they are perceived may vary with the direction of attention to the one or the other of them.

250. Rational Feelings. — Rational experiences may be accompanied by feelings of a higher kind than the sense feelings already mentioned. The joy of victory in a moral conflict, the pleasure of solving a difficult problem, and the delight of successfully carrying out a complicated experiment, are essentially different from the perception of beautiful colors or the design of a Greek vase. Failure in similar experiences induces a distinct feeling of unpleasure, disagreeableness, and mental "pain." Because of the interaction of the sensory and the rational faculties, by reason of their belonging to the same nature, the higher feelings may have a repercussion on the sensory faculties and give rise to sense feelings, but they are not therefore identical with them, since the achievement of rational ends as such causes the higher feelings even when it does not react on the sensory faculties.

251. Feeling and Sensation.—Neither rational nor sense feelings are sensations, for the content of feelings can be only in the psychic faculty, but that of sensations may have extramental existence. In the case of feelings, both act and content (object) are subjective. In the case of sensations, the act is subjective, but its content may be objectivated.

Rational feelings originate from the perception of the relation of objects of thought to the perceiving subject. A candidate for admission to the bar anxiously awaits the verdict on his examination, on which his future career depends. When he is in-

formed of his passing grade, he experiences a feeling of joy. This feeling is founded on his perception of the meaning of the verdict—an object of thought—and its relation to himself. The difference between rational feelings and sensations also appears from the fact that the former may be coincident with physical conditions (as in the case of an accident), which preclude normal pleasurable sensations as their cause. Furthermore, feelings do not arise directly from a peripheral sensory stimulus, since there is no fixed connection between a given sensation and a feeling.

252. Teleological Aspects.—Nature has joined feelings of joy with certain cognitional experiences connected with the welfare of man, in order that he may thus be impelled to action. Feelings of joy attract him to linger over the experiences with which they are connected, and to seek them again. To insure compliance with these aims, nature has joined the organic activities and motor impulses characteristic of love, hate, anger, fear, etc., with these emotions, which follow in the wake of feelings. The love of truth and the pursuit of knowledge and virtue are the highest ends to which nature invites man through his feelings. Yet, feelings are only secondary and accessory motives by which nature moves man to the pursuit of knowledge and virtue, the principles of reason being the primary motives.

When they are left unbridled, feelings and emotions are as detrimental to the pursuit of rational ends as they are helpful when properly disciplined and controlled. Love is proverbially blind, and hatred warps the justice of judgment. In this way

overweening feelings and emotions becloud the proper use of reason, and prevent the concentration of attention on the work to which it should be directed. In extreme cases the physical effects of violent feelings and emotions on the vasomotor organs may work serious injury to their victims.

253. Classification of Emotions.—In the absence of a generally accepted classification of feelings, attention may be directed to the Scholastic division of the emotions.

Wundt distinguishes feelings of pleasure and unpleasure, excitement and tranquillity, tension and relaxation. Lipps classifies the feelings according to the objects, mental directions, and psychic conditions that give rise to them.

The Schoolmen did not study the lower, elemental feelings, which are difficult to characterize otherwise than as pleasant and unpleasant. But they devised a good classification of the emotions (*passiones*), which they defined as acts of the sensory appetite originating from the apprehension of a good or an evil, accompanied by a somatic reaction.[1] The rational feelings, proceeding from the will, are similar acts, except that they have no somatic reaction.[2]

By endowing man with appetitive faculties, nature has so constituted him that he seeks possession of the good that is conducive to his welfare, and strives to ward off evil. When the good can be obtained by simple acts of striving, and the evil

[1] *Passio est motus appetitus sensitivi ex apprehensione boni vel mali cum aliqua immutatione corporis non naturali.* Cf. St. Thomas, *Quæstiones Disputatæ De Veritate,* Q. xxvi, art. 3; *Summa Contra Gentiles,* II, Q. lxxxi, *ad fin.; Summa Theologica,* I, Q. xx, art. 1, ad 1.

[2] *Summa Contra Gentiles,* II, Q. lxxxi, *ad fin.*

averted by merely shunning it, the sense appetite posits the acts of simple appetition or aversion. But, when the good is difficult to obtain because of obstacles intervening between it and the striving appetite (*appetitus concupiscibilis*), the latter is naturally averted from it, and the combative appetite (*appetitus irascibilis*) comes into action, in order to overcome the aversion of the merely striving appetite and to remove the obstacles that prevent the acquisition of the good.

In their relation to the good that is sought and to the evil that is shunned, the merely striving and the combative appetites pass through a cycle of three acts. The presentation of a simple good or evil causes the spontaneous act of attraction (*amor*) or of dislike (*odium*), which is naturally followed by the act of desire (*desiderium*) or aversion (*fuga*). If these acts are successful in obtaining the good, or if they fail to avert the evil, they are succeeded respectively by the emotions of joy (*gaudium*) or sadness (*tristitia*).

If the good is difficult to obtain (*bonum arduum*), or if the evil is difficult to ward off, the combative appetite goes into action. Its first acts are spontaneous attraction toward the good and dislike for the evil. If the obstacle impeding the attainment of the good can be overcome, hope (*spes*) follows; but, if the obstacle is insuperable, despair (*desperatio*) ensues. If an evil can be warded off, a courageous attack (*audacia*) on it is begun; but, if the impending evil cannot be averted, a state of fear (*timor*) succeeds. When the good is finally obtained or the evil successfully repelled, joy (*gaudium*) concludes the cycle; but, if the good eludes the com-

bative striving or the evil overtakes it, anger (*ira*) results.

§ 2. SENSE APPETITION

254. Feeling, Emotion, Appetition.—The Scholastic classification of emotions comprises acts that are essentially appetitive, though they possess emotional elements. Thus, the acts of the combative appetite, seeking to obtain possession of the good or to fend off the evil, are essentially acts of striving; but joy and sadness are purely emotional.

The initial acts of attraction and dislike, and the prosecution of the sensory good or the aversion from it, are essentially different from feelings and emotions of pleasure and unpleasure, for pleasureable and unpleasurable sensory experiences are always connected with a psychic state now existing or with an object actually in the possession of the subject, while appetitive acts tend toward objects not in his possession. Feeling is a passive state, appetition is essentially active.

Reflex attraction and striving cannot be identified with expectation, because a good that is clearly recognized as unobtainable may exercise a strong attraction and become the object of intense striving. Nor are hope and fear the same as the appetition of a good and the active aversion from evil, for the act of appetition may be accompanied, not only by the hope of obtaining the good, but also by the despair of ever acquiring it. Aversion may have for its motive and concomitant, not only the fear of an impending evil, but likewise the confidence of escaping it.

The initial attraction to a good is not identical with

feelings of tension and excitement, though they may considerably modify it, because the initial attraction may distinctly precede these feelings, and on occasion be devoid of them.

255. **The Appetitive Reflex.**—The earliest appetitive acts of the child are reflexes. When a child is in need of nourishment, it experiences a sensation of hunger, which is accompanied by a vivid feeling of unpleasure. This, in its turn, is likely to receive outward expression in weeping, and at the same time the child feels a spontaneous repugnance to the sensation of unpleasure. When the child receives food, it experiences an instinctive attraction for the nourishment and takes it. When the food has been consumed, the sensation of hunger, the feeling of unpleasure, and the unsatisfied attraction disappear, and are succeeded by a feeling of satiety, contentment, and pleasure. The same succession of acts is repeated with every similar occurrence, and the experience thus accumulated is of the greatest importance for the psychic development of every human being.

256. **Desire.**—The repeated experience of deriving pleasure from certain objects and unpleasure from others leads the child to desire the former and to shun the latter. After the object and the feelings resulting from contact with it have become associated in the psychic life of the child, the perception of the object causes the representation of the pleasure or unpleasure derived from it to arise in the child's consciousness. If the representation is one of pleasure, the child is attracted toward the object; but, if it is one of unpleasure, the child is repelled from the object.

This desire for the object differs from merely reflex attraction to it, inasmuch as it is the motivated expectation of pleasure, and the pursuit of the object by reason of this motivation. The expectation of pleasure from future contact with the object is founded on the memory of past experience, in which similar contact produced pleasure, and on the implied assumption that future experience will be like that of the past. This motive impels the child to seek possession of the object again, because it is aware that the pleasure now anticipated in the form of a representation was conducive to its well-being in the past.

257. Origin of Pleasure and Reflex Appetition.— Reflex appetition does not originate from pleasure or unpleasure, nor do these feelings spring from reflex appetition. Both of these experiences arise from the agreement of a physical or a psychic experience now taking place with the normal and beneficial course of human life, or from its opposition to that course.

Unpleasure is nature's indication that a present experience is opposed to the normal direction of human activity. Repulsion from an object is a sign that nature is counteracting an undesirable experience, which has been forced on it.

Pleasure is an index that present experience is in harmony with the normal conditions of human activity. Hence, nature seeks to continue and to repeat that experience, and reflex appetition is the obvious token of nature's intention. Unpleasure never lacks the feeling of revulsion from the object, but reflex appetition of a pleasurable object need not be motivated by pleasure. When the possession of

the desired object has been obtained, a feeling of pleasure naturally results and is often joined with reflex activity seeking to retain the object acquired. The reflex tendency to keep the coveted prize may be so weak that it is hardly noticed while possession is secure, but it becomes prominent as soon as the impending loss of the object is noticed, and ceases only with the realization of inevitable forfeiture or the termination of the pleasurable act.

Feeling and appetition are not specifically different activities; hence, they do not proceed from different principles, but from a single power of the soul—the sensory appetite, which in the sensory sphere corresponds to the will in the rational order.

258. The Influence of Representation on Appetition.—If the representation of an object is accompanied by pleasure or unpleasure, it arouses a reflex attraction toward the object or aversion from it, and, if experience is sufficiently developed, motivated sense desire or repulsion are likewise present. Representations of this kind give rise to a twofold appetition, namely, the desire to have the representation for its own sake and that of realizing its object.

When a representation is accompanied by pleasurable feelings, it is desired for their sake. Thus, the day-dreamer enjoys the world of his dreams and its denizens, and the poet is enraptured by the glories of his teeming imagination.

But, since the pleasure that is anticipated from the attainment of objects in themselves is greater than that derived from representations of them, desire proceeds further and strives to realize and to possess these objects in themselves. This is appar-

ent from the fact that the object is the primary, and the representation only the secondary source of pleasure. The pleasure derived from the representation is only an anticipation of that expected from the possession of the object in itself, or it is the fading memory of such an object. The same inference—namely, that the attainment of the object in itself is the chief aim of desire—follows from the observation that, normally, the more vivid the representation and the closer it approaches to reality, the greater is the pleasure it affords.

However, the anticipated pleasure may exceed that which is derived from the actual attainment of the object, because of an exuberant imagination, because of the absence in the representation of the painful struggle required for the actual attainment of the object desired and of the unpleasure concomitant with its possession, because of the duration of the pleasures of the imagination as against the fleeting character of their realities, or because of a perversion of sentiment. In these cases, desire that is undisciplined by reason and uncontrolled by the will degenerates into voluptuous hedonism flitting from object to object in the attempt to satisfy insatiable desire, and in extreme cases seeking pleasure in pain.

If representations are devoid of pleasurable feelings, there is no tendency to realize their object, and, when these feelings are weak, the acts of the sense appetite are proportionately feeble. An unattainable good, however, may still be the object of ardent desire, as the dying man clings to life until the end.

§ 3. VOLITION

259. Introduction.—The intellect utilizes the data of sensory experience as an instrument for acquiring knowledge of a higher order, and thus the limitless realm of truth unfolds before its contemplation. The principles of science and the First Cause and the Last End of human existence are the chief objects of knowledge to which the intellect attains in this vast field.

Possessing infinite perfection and happiness in His own being, God created man in order that he too might become perfect and happy, according to the endowments of his nature and the gifts of grace, by the development of his intelligence and by the ethical character of his activities in the present life, and by the vision of his Creator in the world to come.

In order to attain this blessed state of union with God, man must pursue the end appointed for him by his Maker with unfaltering steps and with single-minded purpose, and utilize all the means necessary for its attainment. But, just as the mere possession of the principles of science does not suffice for actual scholarship, so the mere knowledge of what constitutes the last end of man is insufficient for the attainment of the ultimate purpose of human existence. Hence, God, who does not fail His creatures in anything they truly need, endowed man with a spiritual appetite, the will, through which the essential ends known by the intellect can be actually achieved.

260. Elicited and Commanded Acts.—The influence of the will extends far beyond this faculty itself into all the activities of man, for the will exercises

a great impelling and inhibiting power on the intellect, the memory, the senses, and the sensory appetite. Hence, a careful distinction must be drawn between elicited acts of the will, which begin and terminate in this faculty itself, and commanded acts, which include all human activities that ultimately originate in the will inasmuch as they are performed by its command, though actually carried out by another faculty.

The object of commanded acts may be an inner act or state (such as the concentration of the mind on a subject of study, or the inhibition of disagreeable memories), or it may be an outward action or state of the subject (such as walking or remaining motionless).

A twofold aspect is distinguishable in commanded acts. The thing or action that is willed is their material object, and the aspect under which it is willed is their formal object. If one asks for food to satisfy his hunger, the food is the material object of his volition, but the allayment of the pangs of hunger is its formal object.

The actions succeeding the act of the will in order to carry out its command, are integral parts of the volitional act. After one has determined to ask for food, the necessary steps are taken to procure it by asking for it, purchasing it, and preparing it. These acts are integral parts of volition, because they are initiated by the will and carried out under its direction.

The acts of the will are performed under the influence of motives. Whenever the will acts, we are more or less conscious of the reason why we perform the action. The motives actuating the will are

highly diversified, ranging from the most primitive sensory objects to the highest ethical motives, but they all have the common character of being a good that is known to the subject willing them. The will cannot strive for an object that is in no way known to the subject, and whatever it seeks is desired as a good. Even when we strive to ward off an evil, the freedom from the evil is the good that the will aims to obtain.

The motives that actuate the will act on it either as means or as ends. When a good is desired for its own sake, it is sought as an end; but, when it is desired because of another good, it is a means. If we desire a pen in order to write, the good of writing is the end, and the pen is the means. A means that would be only such, cannot be willed for itself alone; but, if the means is also known to be a good in itself, it may under this respect be desired for itself, and thus become an end. Hence, the same object, considered under different aspects, may be both a means and an end; and what is initially desired as an end, may in its turn become a means for the attainment of an ulterior good. In this way a large number of objects may be organized by the intellect into a system of motives, one conditioning the other, until an ultimate or supreme end is reached, which cannot rationally be thought of and sought merely as a means. For, in order that anything be conceived as a means, it must be known by the subject as an object that leads to the attainment of an ulterior good; and, on the other hand, an infinite series of rationally subordinated motives is impossible.

261. Experimental Investigation.—Michotte and

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Prum conducted a series of experimental investigations of the volitional experience of choice. The subject was asked to choose between the performance of two mathematical operations, either addition or subtraction—or, in the other alternative given, multiplication or division—on two pairs of numbers. These experiments showed that the subject first considered the alternative operations for the purpose of understanding them. Then he proceeded to evaluate them, usually in the form of a judgment as to their worth, and in a few instances according to feelings of pleasure or unpleasure arising from them, or according to a passive attraction he felt for them. The preferential value of one of the alternatives for the subject led him to choose it. In case no such value was discovered, the necessity of completing the experiment decided his choice. His choice, therefore, was based on different motives, ranging from subjective elements (such as feelings of pleasure or of aversion) to objective considerations (such as facility of action, desire of varying his choice, and the need of finishing the experiment). A brief period of hesitation, or of inhibition, followed the consideration of the motives, and it was accompanied by sensations of tension. Finally, one of the alternatives was judged to be preferable, and the act of choice followed as consent to this judgment. Choice was experienced as an activity proceeding from the self, and as consisting in an act of attitude.

As the number of the experiments increased, the motives of feeling progressively receded, the motive of duty became stronger, judgments became more abstract, and the act of choice tended to become an

automatism. In the interval elapsing between his consent to the experiment and its actual performance, the subject experienced a perception that his action was now inevitable, because he had determined to perform it. He knew that he had assumed an obligation and felt its weight, and he anticipated his compliance with the assumed obligation as a pleasant or an unpleasant experience.

262. Motives of volition are effective only in so far as they are known. They may come into our consciousness through any cognitional act, such as sensations, representations, judgments, or the awareness or anticipation of a feeling. Sometimes they are only implicitly given, as when we make a choice because we remember that we formerly made it from sufficient motives, which, however, are at present beyond recall.

Several methods of procedure are followed in the search for motives on which to base the act of choice. When superficial considerations determine choice, it commonly follows the first impressions made by the alternative proposed. But, when choice is motivated with care, it is delayed by initial superficial consideration of motives, by minute investigations of former evaluations, and by the predominantly negative value of available motives. To bring about the act of choice in this case, recourse is had to auxiliary motives, such as the facility of the act called for in one alternative, the desire for varying one's choice, the desire for consistency, general rational principles, or the need of completing the experiment.

The alternative that is first considered is more likely to be chosen than those examined later, if

acceptable motives are found in favor of it. Priority in the consideration of the alternatives from which the choice is to be made, is more commonly determined by the spontaneous evidence and the consequent immediate perception of the value of an alternative, and less often by its position as the last of the alternatives proposed, and so more intimately associated in time with the command to choose or with the awareness that the necessity of choosing is now urgent.

The analytical examination of an alternative is more likely to yield motives on which choice is subsequently based, than a judgment founded on the general impression made by the same alternative. As a method for discovering motives that lead to a choice between alternatives, analysis is especially resorted to in cases wherein the general consideration of the alternatives reveals negative values.

When the choice between two given alternatives is imperative, the effectiveness of the motives discovered in them is relative to one another. The comparative influence of motives on the choice between given alternatives is progressively greater, according as they are perceived as negative, indifferent, or positive values. Negative values remain such even in comparison with others whose negative character is more pronounced.

Motives that are well known become more and more abstract in consciousness, but motives that are entirely new are at first conceived as foundations of values, and only then are the values based on this foundation perceived. As the number of experiments increases, the effectiveness of pleasurable motives tends to diminish in favor of rational mo-

tives, but that of unpleasurable motives has a tendency to persist.

263. Rationally motivated choice is invariably a volitional act, but choice is not essential for the act of volition. If the intellect proposes a single good to the will, the latter is enabled to posit its act. Furthermore, the will may act without previous deliberation by the intellect as to whether an act is to be performed or omitted, with the result that a "thoughtless" act is performed. In such a case we have only a vague perception of the end as a good, but we fail to consider whether the act is compatible with the attainment of other necessary ends.

264. **Volition and Association.**—The experimental investigation of volition, the chief outlines of which are briefly sketched above, show that volition is an act *sui generis,* and not one that is, or that is essentially conditioned by, association. The psychic influence of the motive on the act of the will that it brings about, lies in the intellectual perception, in the form of a judgment, that the action to be motivated is a means to attain an end, and therefore valuable and desirable in this respect. Association does not determine volition, because the perceived connection between means and end—the only manner in which motives are effective—is a relational experience and, as such, non-associational. Furthermore, no association existing between a motive and the act it motivates, is so strong that it cannot be overcome in the act of volition.

265. **Volition and Feeling.**—Pleasurable and unpleasurable feelings may be connected with volition in the form of motives, concomitants, or effects. If pleasure or unpleasure is the motive of a truly

rational act, and not of an automatism or of a sensory appetition mistaken for volition, it motivates the act only in so far as the intellect judges this pleasure to be valuable and therefore desirable, or decides that the unpleasurable feeling is undesirable, and therefore to be avoided or removed. General experience shows that unpleasure influences the will only by leading it to posit acts that remove this condition, or to use it as the only available means to attain a desired end. Concomitant unpleasure may not only inhibit or weaken volitional acts, but hasten and intensify their performance, and expedite their completion in order to terminate the state of unpleasure. The anticipation of unpleasure has a tendency to inhibit or weaken volition, and the expectation of pleasurable effects tends to hasten and expedite it. The sense of depression following on unpleasurable effects noticeably retards the volitions that succeed them, but pleasurable effects probably facilitate them slightly.

266. Training the Will.—Since the will acts only on the presentation of motives, the chief means of will-culture consists in bringing suitable motives before the mind, in teaching their appreciation, in making them the permanent possession of the subject, and in preventing other motives from superseding them.

The first step to be undertaken in training the will is the establishment of a properly coördinated system of motives in the form of ends desirable for the subject in his capacities as a creature of God, a member of a family, a citizen, a professional man, etc. These motives must be established on a rational basis, not on an emotional foundation, if the

conduct of the individual is to be stable, consistent, and in accord with the nature of man. Emotional motives are short-lived; they pall on mind and will, and they are likely to be superseded by opposite emotions, and thus nullified.

When emotional motives are placed on a rational foundation, they may usefully serve as temporary influences, especially in an auxiliary capacity. Thus, an orator plays on the emotions of his audience; but, knowing well that the hard realities of life will damp the spirits of his hearers, he is careful to base his appeal on intellectual motives, and to drive home his rational grounds by an appeal to the feelings and sentiments of his audience only after he has already established an intellectual conviction in their minds. Emotional motives are dangerous and fraught with possibilities of great and irreparable harm, when they are used to arouse prejudice and to inflame angry passions, because they blind their victims to rational motives and impel them to extravagant excesses in action.

The appreciation of rational motives is instilled by the intellectual evidence of their value for the subject, when his mind becomes capable of grasping it, by showing the conspicuous excellence of the results obtained in actual practice by the faithful use of them, and by the authoritative guidance of the child from the very beginning of his formative period by those responsible for him.

If the individual were faced by the necessity of establishing through personal intellectual effort alone the supreme and all-pervading ends that constitute the ultimate motives of human action, he would be confronted by a task of appalling magni-

tude. Hence, the moral necessity of authority, both divine and human, for the universal, timely, certain, and errorless knowledge of the basic maxims of human conduct in the present condition of mankind.

Motives are permanently effective only when their intrinsic value is permanent. Motives that appeal solely to the emotions and the imagination of children soon lose their effectiveness, even in childhood. Hence, although it is necessary to adapt the motive presented to the will in accord with the individual personality, the mental development, and the character of the child, the end inculcated as the motive of action must be bound up with his whole future, and at least fundamentally independent of his present condition. The basic motives of the child's volition must, so to say, grow up with him. They must be so chosen that, the more he uses them and the better he understands them, the more powerful they become. Appeals to sentiment are by no means excluded, but they must rest on rational grounds of permanent intrinsic value. The effectiveness of the motives of volition is raised to its highest degree when they are united into a coordinated system that is constantly and vividly kept before the subject's mind, so that he realizes that the failure to act in accord with any one of this hierarchy of motives is tantamount to the virtual rejection, root and branch, of all his ethical ideals. It is plain that the ethical standards contained in divine revelation, embodying as they do all ethical ends that are at once supreme and eternally valid, are the only motives really capable of effectively exercising this influence on the will. Nature seconds the educator's efforts by the joy and pleasure re-

sulting from ethically good actions and impelling the child to continue in this course, and by the formation of habits in the direction of the customary course of action, facilitating future acts that are in agreement with the ethical standards according to which the child has been trained, and inclining him to perform the same actions again.

267. Volition a Distinct Activity.—Volition is a distinct activity of the soul, differing from feeling, sensory appetition, and the associational reproduction of concepts and representations. Since the relation of volition to external actions involves the general question of the relation of matter and spirit, the study of the relation of volition to the other psychic activities becomes a relatively simpler matter if it is investigated by comparing volition with intellection, which resembles volition in its purely immanent character.

If a mathematical problem is proposed to us, and we undertake to solve it, we observe several acts taking place in our consciousness. First, we see or hear the problem, and at the same time the intellect seeks to understand it. So far no act of volition has taken place. But, when sufficient motives have been presented to the will, we resolve to assume the task, and accordingly set the intellect to work on it. In this stage of the process, there are at least two acts of the will: the resolution to solve the problem is an elicited act of the will, and the work of the intellect, through which the solution is to be obtained, is an act of the intellect commanded by the will, or a series of such acts.

268. It is plain from the very outset that a mere act of the intellect is not volition, for we may under-

stand the problem thoroughly and yet maintain an entirely neutral or indifferent attitude toward the task of personally undertaking its solution, in which the act of the will consists. The act of volition, which moves the intellect to the performance of its acts, is not only distinct, but, as the sequel will show, essentially different from the comprehension of the problem proposed.

269. When we resolve to seek the answer to the problem and set about to find it, a definite series of intellectual acts follow in the stream of consciousness. Since it is well known that the succession of acts that make up the stream of consciousness are often the result of associational reproduction, it is necessary to investigate the question whether the resolution to solve the problem and the acts of the intellect that follow upon it are the result of associational reproduction.

270. Association plays a useful and important part in determining the succession of the acts of consciousness, but it is not the cause that produces the resolve. For, since concepts usually possess multiple associations, each of the terms in which the problem to be solved is expressed is likely to be associated with several others, similar or different in content. Therefore, the mere statement of the problem will put many multiple associations into readiness for actuation. As a matter of fact, only a few of them are really actuated. Hence, the succession of psychic acts in our consciousness in general, and the succession of the resolve in the case under discussion, are not determined solely by associational reproduction.

Other conditions being identical, the reproduction

of one content in preference to others is in many instances determined by its recentness, freshness, or vividness, by the frequent simultaneous perception of its correlatives, or by strong feelings that accompanied its formation.

But the reproduction of a concept or a representation that is weakly associated with its correlatives also occurs frequently. This experience is accounted for in certain cases by the multicentral connection and development of the correlative that is brought to mind by associational reproduction. For instance, if the concept "book" is weakly associated with that of "school," and strongly associated with that of "library," the attempt to find a correlative to "school" is likely to remain without result in the supposition that this concept has no other associations in memory; but in the same circumstances "library," by reason of its strong association, will promptly call up the concept "book." Then the term "school," still faintly lingering in consciousness, may spontaneously bring to mind its weakly associated correlative, "book." It is entirely plausible to explain this experience by the assumption that the associational connection of "school" with "book," while it was too weak to reproduce the latter representation through the mention of the former, was activated and brought to a state of conscious development by being reinforced through the irradiation of the psychic energy causing the associational recall of "book" by "library."

271. The orderly succession of psychic acts in the stream of consciousness during the hours of wakefulness, including the direction of this order toward the attainment of definite ends, is a characteristic

condition which must be accounted for. The disordered and confused succession of these acts in dreams and hallucinations shows that this orderly succession is not inherent in our psychic acts as such, and must, therefore, be sought in the influence of other psychic factors which prevent the dominating control of the stream of consciousness by external stimuli and associational reproduction. In studying the stream of consciousness from the angle of its volitional acts, the primary question is the reason why, in experiences such as that mentioned in Section 267, the volitional act of resolve succeeds the intellectual comprehension of the problem.

It is evident that association exerts a powerful influence on the succession of our psychic acts. Our habitual attitudes, frequent trains of thought, usual modes of procedure, and familiar methods of research bring about many associations that are spontaneously actuated in everyday life. The general direction given to the activity of the mind by a task on which we are at present engaged, persists even after we have interrupted our work on it and are completely occupied with other concerns. Hence, the resolve to direct our mental activities into certain channels gives to associational reproduction a directional impulse, leading to the selective actuation of those memory dispositions that are serviceable for our present purpose, and to the relative inhibition of those that are not connected with it.

272. In order to establish with greater ease and clearness whether the resolve that leads to the selective actuation of memory contents is an aspect

or a function of association, or whether it is an essentially different act, the distinction between the mental expression of the resolve and its psychic nature must be borne in mind. The content of the resolve is expressed in the form of a judgment—for example: "I shall solve the problem for you"—and it is, therefore, an act of the intellect; but the nature of the resolve is that of intention, will, or determination, which is not an act of the intellect. Since the influence of the resolve on succeeding acts proceeds from its nature as intention or will, not from its expression in judgment, the relation of intention to association must be investigated, as well as that of its expression through judgment.

273. However great the influence of association may be on the succession of acts in the stream of consciousness in individual cases, it is controlled by the intellect, which, in addition to performing this accessory function, plays an even more important part, peculiar to itself, in effecting this succession, since the succession of judgments in acts of inference is a purely intellectual process. Association brings a temporal succession of concepts and representations and supplies material for judgments, but the perception of relations and their predication of objects of thought is an entirely different and therefore distinct act of a higher or spiritual order. Furthermore, since every judgment is necessarily true or false, it is essentially different from association, which cannot have these properties. The intellect judges of the associations presented to it, and accepts or rejects them at pleasure. It would be absurd to maintain that the succession of judgments and inferences posited in the process of solving a

mathematical problem are a mere succession of associations. Hence, the intellect dominates and utilizes in its own specific manner and for its own distinct purpose the material furnished to it by associations, and it is therefore an even more important cause that brings about the succession of psychic acts.

274. The resolve to work out the solution of a problem does not consist in the intellectual acts by which the solution is obtained, for it is the cause of which they are the effect. Volition is that spiritual act of attitude which brings about the actual use of the means known to the intellect and judged by it to be suitable for the attainment of a known end. As a result of volition, all the required faculties of the soul are put into action for the attainment of the desired end, the individual bends all his powers toward the prosecution of his aim, and he realizes its accomplishment as a task incumbent on him. When the pursuit of the desired end is pleasant or easy, it may not be perceived as the exercise of the spiritual striving power inherent in the soul; but, when the end is difficult to achieve and formidable obstacles must be overcome, the awareness of the effort put forth is distinctly perceptible. Endeavors may flag, and volition and the acts it commands may weaken and finally cease, though the full comprehension of the task remains vividly in the mind. These facts show that volition is a specific activity of the soul, distinct from all sensory acts and from intellection. The specific function of volition is to strive for an end as known by the intellect, and to bring about those activities of the soul that are necessary for its attainment.

Since a specific activity requires a specific principle for its cause, the will is a specific principle, distinct from the intellect and the sensory faculties, and proportionate to its own object. If the will is considered with reference to the function that is proper to it, it is a spiritual faculty of the soul that strives for an object known as a good by the intellect, and applies the other powers of the soul to do the acts by which this object is attained.

275. An organic faculty can intend and strive for material objects only. Hence the will, striving for abstract and spiritual objects, is a spiritual faculty of the soul. The will loves virtue as such, and hates vice as such. It strives for wisdom and knowledge, for goodness and honor. Now, all these objects are incapable of exciting an organic faculty, and they have no meaning whatever for it. Organic faculties are necessitated to action by their object, and invariably obey the laws of their nature, but the will can remain indifferent and inactive in the presence of its object, and its future course of action cannot be calculated with certainty and formulated like a natural law. Ethical standards are essentially foreign to organic beings, but man, by reason of his will, has always been recognized as a moral being. Animals may be trained by intimidation and attraction, but praise and blame, imputability and responsibility, education and character are reserved for beings that rise above natural laws and originate their actions from themselves.

276. **Genesis of Commanded Acts.**—The psychological antecedents of commanded acts, without which they would not take place, form a complex process, the details of which often remain un-

analyzed and unnoticed in consciousness, partly because some of these antecedents appear but faintly and briefly in our perception, and partly because they are often so closely joined with one another that they remain undistinguished.

277. The remote antecedents of commanded acts are found in the individual's capacity for performing the various acts that constitute the sum-total of human activity, and in his awareness through experience that he can perform many and varied acts. He also possesses a natural inclination to be active, and he experiences a sense of well-being when his faculties are normally active and a feeling of discomfort when they are abnormally inactive. Many acts, once performed, attract him to repeat them, and many objects spontaneously incline him to strive for them. The memory of his past experience brings up before him representations of acts and objects as a future outlet for his impulse to be active. Thus, he becomes aware of many potential ends toward which he may direct his activities.

278. Experience and reason teach him that the attainment of many of the objects made known to him through his cognitional faculties is a good, and that, if he desires to develop and perfect himself physically, intellectually, and morally, the avoidance of other acts is imperative. This is the knowledge of objects as ends, and it consists in the perception of the effect that the attainment of known objects, either in their physical being or in an ideal form, produces on him, in its relation to the laws and conditions of his being. Since man is a rational being, and must therefore attain rational ends, he distinguishes attainable ends into such that are in

accord with his rational nature, and such as are in accord with his sensory nature, but opposed to reason, and are consequently only seemingly good ends for him.

279. Experience also teaches him that his acts serve to attain many objects he has known to be good in relation to himself, and that he has the power of so directing his activities that he will further the ends he has previously known. This is the knowledge of actions and objects as means. It is an act of the intellect, because it implies the relational perception of the connection between the acts of the subject and the objects to which they tend either by their own nature or through the intention and direction of the agent. A child knows through experience that, if he drops a stone, it will fall to the ground. In the same way he is aware that, if he desires to see the ripples in the stream, he can so direct the course of the stone that it will fall into the water and produce the waves he delights to observe.

280. Motivation is an essential condition of volitional acts. Every act of striving that is not in fact motivated, is an automatism or mere sensory appetition. The motives on which acts of volition are based, are always found in acts of the intellect. Whenever, therefore, no rational ground is present in the mind or, having previously been present, is no longer virtually operative, there can be no volitional act. Those who have not the use of reason or, though possessing it, do not posit a given act under the influence of reason, are not willing it. They may under circumstances be amenable to law and held responsible for the omission of volition, or

the volition may be legitimately presumed, but this legal aspect, necessary and just as it is, does not change the psychological nature of an act.

The will is a "blind" faculty, unable to posit its act except the intellect presents to it the object to be willed. But, since the will has a natural inclination toward every good, it is the duty of the intellect to propose to the will only such objects and acts as are in accord with the rational nature of man. All others must be held up to the will under their aspect of evil, in so far as their attainment does not further the purposes of man's rational nature or of his sensory nature as subservient to rational ends. When these evil aspects are compared with those that are good, they always outweigh the latter as rational motives in the ethical scale, because ethical values are determined solely by the agreement or disagreement of objects and acts with man's rational nature and with the ends essentially given with it, or otherwise legitimately appointed for it.

281. Motives of volition differ from the power of acting and directing our actions, and from the knowledge of objects for which the will can strive. Motives are the rational grounds of volition, making us aware that acts and objects are desirable, advisable, imperative, or the contrary. The power to act and the inclination to act are common to all the faculties of man. The power to direct actions resides in the sensory as well as in the rational nature, for even in animals instinct guides their acts. The awareness of objects for which we can strive comes through sensations and representations as well as through intellectual cognition.

282. Motives are not the efficient causes of vo-

litional acts. The relation of the eliciting principle to its act is the relation of cause and effect, and it is therefore in the real order. Motives being judgments, they are in the ideal, cognitional order. Motives are the rational basis and justification of volitional acts, but knowledge is not an efficient cause. Motives are the judgments on which the mind's approval of a contemplated act of the will is founded, but cognition is not a physical impulse to action. The realization that a given act is imperative moves us to perform it, but such realization is merely the full and vivid appreciation of the reasons why the act should be performed. When purely somatic conditions, unconscious impulses, or habits are definitely assignable as the motives of acts, two cases must be distinguished: either these antecedents are the total cause of the act, and then it is not volition; or they are its partial cause, and consequently, as belonging to the real order, not to that of cognition, they are not true motives.

283. The presence of motives does not in itself bring about volition. When the commanded act is fully deliberate in all its integral parts, the intellect judges of the motives, of the act to be performed, and of the object toward which the act tends. This judgment is the rational attitude of the subject toward his volition, consisting in the approval or rejection of motive, act, and object. If all motives are rejected, volition does not follow. If any motive is approved, the will may or may not consent to the act, and actuate the faculties that perform it. The intellect approves or rejects the act in the concrete, as proceeding from the subject under given conditions, for volition is always directed toward the per-

formance of individual acts, as proceeding from the subject himself. We may approve or condemn the acts of others, but this is not an act intrinsically preparing our own volition. The acts and objects approved or rejected need not lie in the future, for we may detect ourselves in the actual performance of automatisms or acts of sense appetition, and approve or condemn, continue or cease them, by an act of the will when they are already in progress.

The approval of acts to be performed in the future and the resolution to carry them out, entail important consequences from the time the resolution has been formed. When the resolve to perform a given act in the future is a true volition, and not a mere wish or velleity, it impresses itself on the memory, and the agent deliberates on the means to be adopted for the performance of the act intended. In due time he takes all measures necessary for the performance of the act, and, when the moment for action has arrived, the resolution is actuated in his memory and inclines him to carry out the contemplated act. When the apparent resolution produces no effect whatever tending toward the performance of the act, it is hardly more than an empty wish.

284. The commanded act is not elicited by the will, but by the activity of other faculties, which are actuated and directed by the will. Volition being the cause that brings about the acts of the faculties under its control, it is logically prior to them, but they retain their own nature as acts of the intellect or of the sensory faculties. The activities of these faculties are termed voluntary, in so far as the will actuates them, applies them to their object, and controls them. Volition cannot be substituted for the

acts of the faculties under its command, because the will is incapable of performing their acts, and because the commanded acts may be separated by a considerable interval of time from the elicited act of the will. The resolutions of to-day may be incapable of realization until future events have transpired—by which they are conditioned.

285. **Motivation.**—The impelling power by which motives incite the will to action is a characteristic that distinguishes the judgments we term motives from other knowledge the agent possesses. In order to discover wherein the impelling power of motives consists, the respects under which objects can be willed must be analyzed. An object is willed either as a means or as an end. It is willed purely as a means, when it is desired only because it is the medium through which another object is attained. An end is willed either because of an ulterior end (whence it is termed a proximate or intermediate end), or because of itself alone (in which case it is the ultimate end of volition).

The impelling power of means that are willed lies in the judgment that they are conducive toward the attainment of an end that is known and willed. The agent makes use of the means, because he knows that they will realize for him the object of his desire. The same object or act can be the means for attaining ends differing greatly from one another. A journey may be undertaken as the means for expediting business, for visiting friends, for consulting a physician, or for making scientific investigations.

286. An end that is willed may in its turn be the means for attaining ulterior purposes. In this case it is an intermediate end, and is motivated in the

same manner as a means. The intention of realizing an ulterior purpose through the attainment of an object is the criterion by which the object of the will is known as an intermediate end. Such ends are many, and they are usually contained in the general aims and ideals, the knowledge and principles, the character and temperament of the agent.

In order that an object be willed as a means or as an intermediate end, the agent must possess an actual or habitual knowledge of the ulterior end to be attained, and of the real or presumed relation of the means or the intermediate end to the ulterior end, as the medium or instrumentality through which the ulterior end in question is to be attained by the agent.

287. The ultimate end does not move the will in the same manner as a means or an intermediate end moves it, for it cannot derive its impelling power from an ulterior end. Hence, its motivating power must proceed from another source.

The ultimate end of volition, considered from its subjective aspect as a state to be realized in the agent, is happiness or beatitude—the subjective correlative of the good-in-general, for which the will by its nature strives. "As our intellects can rise above all particular being and think even of being itself in general, so the will can desire the good-in-general and happiness-in-general. That is the adequate circle of the will's desires. Within that circle it can and must choose its particular ends."[3] This direction of the will, in so far as it is a spontaneous and inborn tendency, is not volition, because it does not proceed from rational motives. But, as actuated

[3] CRONIN, *The Science of Ethics*, I (1909), p. 54. Cf. pp. 47–86.

in particular acts of volition, it becomes volitional when the intellect perceives the necessity of this general end for the agent by a consideration of his nature. The knowledge that the true perfection of man results from the pursuit of what is a good in relation to his rational nature, gives to this general motive a moving power with regard to all acts and objects in which it is embodied. Hence, the ultimate end of volition, subjectively considered, draws its motivating power from the intellect's knowledge of its relation to the nature of man.

288. God, as the Perfect Good, is the ultimate objective end of volition, because He alone can fill up the capacity of the will for desiring,[4] and is, therefore, the only object that is ultimately desirable for itself alone. The consideration of the essential relations objectively existing between the nature of man and his Creator establishes the Perfect Good as the ultimate objective end of volition.[5] On the one hand, God *is* the Perfect Good, and, on the other, the will is so constituted that only the Perfect Good can completely satisfy its desire. Moreover, an end appointed by nature is a reality that can, given the proper conditions, be actually attained; and complete satisfaction of natural appetites under the proper conditions is the reason of their existence. Hence, God, as the Perfect Good, is a real, attainable, ultimate objective end of volition. Hence, also, the ultimate objective end of man derives its motivating power from the intellectual knowledge of the essential relation of the agent to it.

289. In conclusion, it is plain that motives and

[4] CRONIN, *op. cit.*, I, chapter 3.
[5] LECLERCQ, *Leçons de Droit Naturel*, I (1927), pp. 68–102.

ends are not identical. An end is the object desired on its own account by the will. A motive is the intellectual knowledge of the object in so far as the latter is a good in its relation to the agent. Motivation precedes volition; the attainment of the end follows on it. A judgment can exercise its motivating power even though it is an erroneous conviction of the relation between means, ends, and the agent, for this power arises from his subjective persuasion, not from the objective truth of the judgment.

290. Influence of the Will on the Other Faculties. —The will has a limited control over the acts of the intellect. By bringing about the actuation of the fantasm in the imagination or the action of the senses, the will has absolute power (*imperium despoticum*) to compel ideation. But the will has no power whatever to control self-evident judgments, and only a relative power (*imperium politicum*) over those that are not self-evident. Acceptance of self-evident judgments is forced on the intellect by their evidence, but it may accept or reject judgments that are not evident. Attention is largely under the control of the will, and by directing attention to an object or averting it from the object, the will to a great extent can increase or lessen the effect of the object on the sense appetite.

Under normal conditions the will has a great but not absolute control of the imagination by bringing about the actuation of fantasms or their inhibition. This control is lost in various psychopathic states. The will controls the external senses in so far as it can prevent their contact with their object. By closing the eyes, the will prevents the sensation of vision, but, when they are open, sight cannot be inhibited.

The vegetative activities are beyond the control of the will, but the motor faculty is largely under its control.

§ 4. FREE WILL

291. Method of Procedure.—The freedom of the will is most conveniently studied by examining the nature of volition, for, if the experience of freedom is made the point of departure, various difficulties are likely to complicate the investigation and render it more difficult. Freedom is diminished at times by external factors that, to a greater or lesser extent, interfere with its exercise, as when the will acts under the influence of powerful emotions and passions (such as anger and fear). The concrete acts selected for examination may also be so intimately bound up with a complex group of psychic activities that it is difficult to single out clearly for observation the volitional acts from the whole mass of simultaneous psychic phenomena of which they are only a part. Finally, it is sometimes very difficult to distinguish volition in the concrete from automatisms and acts of sense appetition that possess a certain external resemblance to them.

292. Freedom.—In general, freedom is the absence of compulsion, the power of self-determination. Various kinds of freedom may be conceived. Liberty of contradiction is the power of choosing between the performance or the omission of volition with regard to a known object. When asked what our attitude is toward a bill before the legislature, we may choose either to adopt an attitude toward the proposed law or to remain quite neutral, neither favoring nor opposing it.

Liberty of contrariety is the power of choosing between volitions that are contrary to each other with regard to a known object—for example, the power of choosing between active support and opposition with regard to a bill before the House, or between the practice of a virtue and indulgence in the vice opposed to it.

Liberty of specification is the power of choosing between two or more known means or intermediate ends, such as communicating our intentions by cable, radio, telephone, or letter; travelling to Europe by the northern or by the southern route; entering the legal or the medical profession.

In all these instances, liberty is ascribed to the act elicited by the will, and to commanded acts only in so far as they are actuated or controlled by the will, whether as consequent on a given volition or as preparing it. In the same connection, choice is not intellectual preference, but volition based on this preference expressed in the form of a judgment, as on its motive. Free will, therefore, is the power of acting in accord with the motives proposed by the intellect, but without being necessitated by them. The will determines itself to action in the light of rational motives, but, since it is a free faculty, it may choose to disregard them and decline to act. The will may likewise act on motives that are proposed by the intellect, and that are in this sense rational, but these motives need not be in accord with the rational nature of man. Such acts, while psychologically possible, are ethically unjustifiable, except when the motivating judgment is a bona fide error. The will would be entirely safeguarded against the presentation of unjustifiable motives,

which are not in agreement with the essential relations of man to God and His creatures, only in the case that the human will were essentially immune from error.

293. Freedom and Motivation.—Rational motivation, and hence, under this respect, freedom of volition, is possible even if the intellect presents to the will two motives possessing identical motivating power in every respect regarding the same object. For, though there can be no objective preference for either of the motives in this case (since both of them are in every way equal), yet each of them enables the will to act in accord with rational grounds. Although a choice between them is unnecessary for the volition of the motivated act, it can, if desired, be motivated by rational grounds extrinsic to these motives, such as the moral obligation to do the act, the need of completing an experiment, or the desire of exercising one's power of volition.

The last-mentioned ground is also a sufficient motive of volition when perfectly equal motives militate for and against a given act. The same rational but not always ethically justifiable ground is available when the motives in favor of a given act are insufficient to move the will to perform it. Volition is psychologically possible in this case, but, like its motives, it may be ethically unjustifiable. However, if the intellect could present no negative grounds whatever to the will in the face of a sufficient motive of volition (not even the most subjective and personal motives, such as the exercise of the power of volition), the will would not be free as against the motive presented to it, and its act would inevitably follow.

294. Since motivating grounds are numerous and varied (both favoring the act of the will and opposing it), and since the will can act in accord with any of them, its action cannot be calculated in advance with certainty, nor logically deduced from a knowledge of the motives present to the will. This would be possible only in the erroneous hypothesis that volition is contained in its motivation like a conclusion is contained in its premises. Volition and motivating cognition are specifically different acts, and volition is conditioned by its motives, but it is not effected by them. Volition is not necessitated by reason, either as an eliciting cause, or as issuing an irresistible command.

295. Free will is the spiritual power of a rational being to determine its own volition according to intellectual motives. The power of acting in opposition to rational motives is not essential to free will, but rather an imperfection given with the present condition of man, just as the liability to error is an imperfection of the human intellect.

296. **Sense Appetition and Volition.**—Volition and sense appetition may harmonize with one another, they may be opposed to one another, or the one faculty may be neutral toward the objects and acts of the other.

When both will and sense appetite strive for the same object, the agent pursues it by the harmonious exercise of his striving faculties, and is most strongly drawn toward it. On the other hand, many acts of striving are initiated by the will alone, and, while the object is thus sought by rational acts, the sense appetite also becomes attracted to it, and the full activity of both faculties is directed toward its

attainment. The study of a literary work may be taken up purely as a matter of duty, and in the course of the work the sense appetite may be drawn to it by the beautiful images it presents to the imagination. The opposite condition obtains when the sense appetite is attracted to an object, but the will is not inclined to it at once. If the intellect on deliberation finds rational grounds for seeking the object, it coöperates with the sense appetite, and both faculties strive for it harmoniously. Thus, one may experience a sense of exhilaration in outdoor pastimes, and, finding them beneficial to one's health, one may seek them for this rational end.

297. Opposition between sense appetite and volition is frequent. The will may seek an object to which the sense appetite is opposed, as when disagreeable medicine is taken, or when a painful operation is undergone. Violent conflicts may arise when the will is called upon to stem the tide of sense appetition. A long and intense struggle between the two faculties may ensue, and the final victory may fall to either of them. A keen sense of injuries unjustly suffered may excite a spirit of resentment that would revenge itself by deeds of violence, from which the agent restrains himself only by departing from the scene and directing his mind into other channels. The opposition between volition and sense appetition shows that these acts proceed from two distinct faculties.

The sense appetite is neutral when the agent applies himself to purely intellectual work, in which the sensory faculty can find no object. The will remains neutral when the mind fails to notice the promptings of hunger, or allows the physiological

phenomena of thirst to take place for the purpose of observing them, but without a thought of satisfying them.

298. In a concrete case it may be doubtful whether a given act proceeds from the sense appetite alone, or from the will with the coöperation of the sense appetite. Such acts undoubtedly proceed from the will when they result from a careful and attentive consideration of rational motives in a calm state of mind. Ignorance, passion, and violence may diminish and, in extreme cases, destroy their voluntary character.

299. **Determinism.**—Volition is not adequately accounted for by rational motives, not only because they are not efficient causes, but because in many instances there is no preponderant motive for any one of several possible acts, and yet the will performs one of them and omits the others, which were just as strongly motivated and equally easy of accomplishment. Hence, the cause of volitional acts is a factor extrinsic to its motives.

According to the determinist theories there is no spiritual soul endowed with a will as the eliciting cause of volitions, but these acts result from other conscious or unconscious processes that take place within ourselves. These processes are feelings, sense striving, instincts, reflexes, representations, sensations, associations, judgments, habits, and personal dispositions to action. Since the act of volition, in the determinist theory, is completely dependent on the causality of these factors, it necessarily follows when they are present, and inevitably possesses the individual form and character they impart to it. As the determinist rejects the doctrine

maintaining that the soul is a spiritual substance, he is likewise unable to accept an eliciting principle of volition and of the psychic acts by which it is determined. If there is no soul to elicit the act of volition, this act must be the result of the conscious and unconscious processes preceding it and tending toward it. There are no other antecedents and causes from which it could proceed. Only the soul could initiate and carry out a decision between motives and acts, and by its own activity adopt one course in preference to others that are possible.

300. Indeterminism.—But, granting the existence of a spiritual soul, it is the eliciting principle of volition. The motives of volition exist in the ideal order. They are the grounds of volition, but not its eliciting cause. Yet, volition is not, therefore, an effect without a cause, for the soul is the cause that posits it. The activity of the soul is not like that of a mechanical cause, which acts only by transmitting an impulse applied to it.

The soul exerts an active and controlling influence, proceeding from itself alone, on the course of thought by establishing metaphysical relations between concepts in the acts of judgment, and by regulating the succession of thoughts according to the scientific principles of truth, the canons of evidence, and the requirements of method. Outside the intellectual sphere, the soul directs the course of association and memory, the expression of thought in language, and many movements of the body. Its causal influence extends to the bodily organs through its control of many physiological activities of the nervous system.

If the soul, then, performs these acts, some of

them purely immaterial and others controlling and directing sensory activities, it is by no means improbable in principle that the soul should also possess a striving power (spiritual in character and operating spontaneously by its own causal initiative, independently of sensory stimulus and of the laws of the sensory faculties) as a correlative of the intellect, just as the sense appetite is the complement of the faculties of sensory cognition. According to the indeterminist doctrine, therefore, free will is the soul's power of spontaneously striving for an object known by the intellect as a good. This power includes the capacity of refraining from striving for any particular object proposed to the will, because this direction of the will away from any object is also an attitude that can be rationally motivated, and hence it is in itself a good and an object of volition.

301. The Will is Free.—The freedom of the will, in the sense explained, is proved by our inner consciousness of freedom in volition, and of responsibility for our acts.

We are aware that our acts are our very own, that we approve them and consent to them. We decide our actions in advance, and carry them out in due time. We make them contingent on future events and shape them accordingly, even in the face of difficulties and of natural inclinations that would avert us from our chosen course. These free acts of the will are clearly and easily distinguished from others that are not in our power. We cannot but strive for what is good; yet, this general direction toward the good, which is not in the control of the will, is very different from our free choice of a

book for reading or of the material with which to build our homes. The motives of the same action can be varied at pleasure, and the same motive may give rise to opposite acts. A given motive is spontaneously effective at one time, but on other occasions it leaves us cold and indifferent, and then only an extraordinary effort of the will makes it effective. During the performance of our actions, we can cease them abruptly or change their course at pleasure, and we can with equal ease revert again to our original plan of action.

302. These facts are not explained by the remark that our actions are free from outer compulsion, but determined by necessitating laws of our being. For the efforts of the will are often strangely baffled in futile attempts to command the intellect to understand and the memory to recall. Here there is no necessitating law of volition that is put into operation, nor is there an unconscious factor that necessitates our volition. We are conscious of the act as proceeding from ourselves, and the hypothesis of an unknown cause necessitating it is entirely gratuitous. Such an hypothesis is not only devoid of any foundation in fact, but it fails to account for the known data of volition, and it is therefore unscientific.

303. A sense of responsibility, common to all mankind, originates from the knowledge that the acts of our will, by which we strive for objects or refrain from striving for them, are in our power and under our control. These acts are clearly apprehended as volitions, and distinguished from the natural inclination of the will and of the sense appetite toward their objects. The control that we have over the

elicitation of volitional acts and over their omission is recognized as the reason why we hold ourselves responsible for them. We feel no responsibility for acts beyond our control. When the control of a course of action initiated by ourselves is taken from us and assumed by another, we feel a sense of relief because the responsibility now rests on him, and he on his part becomes conscious of the strain of responsibility that did not weigh upon him before. These are, briefly stated, the facts and the causes of responsibility.

The knowledge that we are responsible for our acts has no sufficient reason except the spontaneous and free control over its own acts by the will. If volition were the necessary result of antecedent psychic acts, brought about by heredity, environment, habit, education, and personal dispositions, neither this act nor the acts that prepare it could be under the control of the agent. He would deserve neither praise nor blame, neither reward nor punishment, for his deeds. No system of education and training can be devised, and no course of human life can be so planned, that the antecedent factors of volition in the determinist theory—both personal and environmental factors — will invariably and automatically result in those acts of the will that are in accord with the various ends of human existence. Even the theoretical formula of such a Utopian program is beyond the fondest dreams of the psychological and eugenic laboratory.

Freedom of volition, with the responsibility and imputability of human acts consequent on it, is one of the fundamental convictions of man. It is so necessary for human society that nature cannot

leave us in doubt or ignorance concerning it. Without free will the social duties of justice and obedience, the entire moral law and all human ideals become deadly illusions or tyrannical codes of domination foisted on the race by the selfish designs of oppressors. These absurd and fatal consequences, which necessarily follow from a thorough-going determinism, are a standing refutation of the principles from which they spring.

Collateral Reading.—Mercier, *Manual of Modern Scholastic Philosophy*, Vol. I, pp. 263–83; Maher, *Psychology*, Chapters XVIII–XX; Moore, *Dynamic Psychology*, pp. 101–33 (Emotions), pp. 311–401 (Volitional Control); Pyne, *The Mind*, pp. 234–62 (Sense Appetite, Emotions, Instincts), pp. 324–57 (Will); Gruender, *Free Will;* Barrett, *Strength of Will;* Gates, *Elementary Psychology*, Chapter IX (Rôle of the Dominant Urges in Habit Formation).

Seashore, *Elementary Experiments in Psychology*, Chapter XV; Snow, *Psychological Problems*, Chapters VIII, IX, XV.

CHAPTER X

THE SOUL

§ 1. SUBSTANTIALITY OF THE SOUL

304. Method.—Since we possess no intuition of the soul and cannot subject it to experimental investigation, inference from our psychic activities is the only scientific method available for acquiring a knowledge of its existence and nature. The psychic phenomena, from which all deductions as to the reality and the properties of the soul must proceed, do not merely include the acts of rational and sensory cognition and appetition, but also the fundamental psychic fact of consciousness, through which we possess an immediate awareness of these acts. Intellection, volition and the other psychic acts do not take place, as it were, in solitary isolation, but as acts of ourselves and as belonging to us. The consciousness of psychic acts is as universal as these acts themselves, and it is an essential part of psychic experience. Hence, there is in all men a subject of psychic activity, possessing an immediate awareness of its acts. This subject knows its own existence through the experience of its activities, for existence is a prerequisite for any activity as such.

305. Reality of the Soul.—The manifold psychic activities of an individual person are all in the same subject, because we institute direct and immediate

comparisons even between the most diverse experiences that take place in our consciousness. Thought is not only compared with thought, and sensation with sensation, but feeling and thought, volition and sensation; in fact, all psychic activities are brought into immediate and direct comparison with equal facility. If the experience of thought took place in one subject, and that of feeling in another, each would be perceived only by its own subject, and no immediate and direct comparison of both experiences with one another would be possible. The immediate comparison of all psychic experiences with each other in the same subject establishes the unity of the subject of psychic experience.

306. The subject of the psychic experiences of an individual is permanent, because the characteristic of the experience of memory lies in the recall of past acts as having been experienced by the same subject that now revives them into consciousness.

307. The subject of psychic experience is more than merely conscious of its activities: it is the entity in which they take place, for nowhere in nature do we find an activity isolated from its subject. In fact, activity is conceivable only as a process of change that takes place in a subject. Motion cannot exist for itself, but only in the object subjected to this particular kind of change. Similarly, thought, volition, and all forms of psychic activity cannot exist in themselves, but only as a process of change occurring in a psychic subject. If thought and the psychic subject that is conscious of it were separated from each other, the immediate consciousness, which every individual possesses of his psychic activities, would be impossible. The individual

would know his own activities only as he knows those of other persons, through a medium of communication.

308. The reality of psychic experience vouches for the reality of its subject. Thought and feeling are not logical entities; our experience of them is that of actual and vivid realities. Hence, the principle in which they take place must be proportionate to them, and a real entity of the same nature as themselves.

309. The subject of a psychic experience is its eliciting cause. We possess an immediate awareness that we produce the volitions we experience as our own, and elicit the memories that loom up before us. We direct the course of our thoughts into definite channels and keep them there. Of our own volition, we combine judgments in order to deduce inferences from them. We deliberate on various means to achieve a given end, and at a given moment, perhaps after the lapse of years, we perform the acts previously chosen as conductive to the desired end.

310. The subject of our psychic experiences is the soul. From the foregoing exposition it is plain that the soul is the unitary and permanent principle of psychic experience in an individual person. This is, as yet, a very imperfect concept of the soul, far from adequate, and far short of the bounds of possible knowledge. An adequate concept of the soul is impossible on the sole basis of inference from its activities, but even this limited understanding is the more precious in proportion as its full comprehension eludes us.

311. Soul and Brain.—Psychological materialism

seeks to identify the soul with the brain, its functions, or its product. The appeal of this theory, like that of materialism in all ages, lies in the concrete and definite processes on which its theses are based, and in the ease with which they are grasped, rather than in the evidential value of its material.

312. Psychic life is profoundly influenced by pathological conditions of the brain and the nervous system, induced by disease, lesions, and drugs. The sensory faculties are impaired, the use of reason is inhibited, the will becomes powerless, and the condition known as multiple personality results. But these premises do not warrant the inference that the brain or its functions are the soul. They merely prove that there is a connection between the normal condition of the brain and the normal activity of the soul, as long as both are united into one substance. The identification of the brain and its functions with the soul, because the normal activity of the latter depends on that of the former, is as erroneous as the identification of an electric motor with one of its parts on the ground that the motor does not work if one of its parts is defective.

313. A comparison of the physiology and chemistry of the brain with the variety and nature of psychic experience shows that the terms of comparison are essentially different from one another. The diversified forms of the content of consciousness, and the numberless differences occurring in each of them, have no parallel in the functions of the brain, and therefore are not identical with them. Countless visual sensations, representing an almost unlimited variety of objects, have no counterparts in the electrical and chemical processes of the brain.

The multitude of ideas that pass before the mind's eye are combined into judgments and inferences, for which no physiological parallel is conceivable. Hence, it is an unwarranted inference that the soul and its activities are identical with the brain and its functions, or their aspects.

The extension of matter, the divisibility of material things, the physical contact of objects with one another, the collision of mass with mass, and the local motion of bodies in space are fundamental properties of physical objects, but they are entirely lacking in psychic experience. Psychic acts have neither height nor depth, they cannot be divided, they do not touch one another, nor do they move about. Matter is not conscious of itself, but consciousness is essential to psychic experience. Activities and properties, so disparate as the physical and the psychic, proceed from principles as different as themselves, because a principle must be proportionate to its activities, and a cause must contain in its own entity the sufficient reason of its effects.

314. Associationism.—The associationist theory considers the soul as the totality of psychic acts contained in one consciousness and connected by means of associations. It does not regard the soul as a mere aggregate of juxtaposed acts, but as a connected unit. Just as leaves, branches, trunk, and roots are a tree only when they are joined into a living unit, so the psychic acts of an individual are a soul only when they are united in a living being. The ego appears to be identical and permanent only to the superficial observer; in reality, it is constantly changing. There is no permanent psychic principle, but merely a permanent condition for

psychic happening. In the actual occurrence of psychic experiences, real relations are established between them through acts of comparison and distinction, in consequence of which they are connected with one another by means of subconscious associations. This connection constitutes the unity of consciousness.

315. Since associations such as those described are non-empirical, their acceptance is equivalent to the surrender of the empirical point of view in psychology, and, at least in principle, it opens the way toward the doctrine of the substantiality of the soul—a position upon which the associationist looks with no friendly eye. If these associations are material, they lead to psychological materialism: if they are psychic, their permanence implies a permanent psychic entity in which they inhere, and of which they are dispositions. Furthermore, associations of this kind fail to account for the immediate and conscious connection existing between various psychic acts prior to the formation of associations between them, as in the case of reflex attention directed toward the progress of an act of volition. In addition to these difficulties against the associationist theory, the concept of association does not express the nature of the subject of psychic experience, for association is the bond that joins individual experiences with one another, but their subject is the perceiving agent that knows and relates them. Finally, the spiritual nature of intellection and volition is definitely proved, and it cannot be reduced to a material function of the brain or the nerves.

The dissociation of a personality does not prove

the associationist theory, because it is either the inability to recall certain groups of past experiences, or the breaking down of memory residues that joined them with the remaining content of memory. Alternating personality is the pathological association of certain series of psychic experiences and of reactions to them in groups, and their periodical recall.

316. The Actuality Theory.—According to Wundt, all existence is activity, and psychology is the science of our immediate experience of this activity. Since we possess no experience of the soul substance, Wundt identifies the soul with one of our psychic activities. He classifies our psychic activities as representations, feelings, and volitions, the last-mentioned including all acts of the intellect. Having excluded the existence of a soul substance, Wundt bases the unity of consciousness on psychic activity. Representation is not its basis, because it results from an external influence, and hence presupposes the fundamental unity of consciousness. Feelings do not effect it, because they are a modification of volition. With representation and feeling excluded, volition alone remains as the foundation of the unity of psychic life in the individual. Representation and volition are basically similar inasmuch as both are psychic activities, but representation is the activity of the subject that is forced on it by the object, and volition is the spontaneous activity of the subject. Having thus reduced psychic activity to a voluntaristic basis, Wundt proceeds to explain the permanent identity of the ego as the perception of its volitions as continuous, homogeneous, successive activity. Impulse and in-

stinct are its most primitive form, association and intellectual apperception are progressively higher and more perfect forms of spontaneous activity.

317. The exclusive use of the empirical method is a defect of Wundt's procedure in seeking to establish the nature of the soul. All principles derived from reality, including the abstract principles of reason, are legitimately applied to the study of reality, whether mental or extramental. On the other hand, the theory of Wundt cannot be formulated on the basis of the purely empirical investigation of psychic activity.

Volition and representation are not, as Wundt claims, fundamentally identical. If they were identical, they would be inseparable, and neither could be experienced without the other. Volition always presupposes that its object is known to the intellect, but intellection does not necessarily include feeling and volition. The intellect knows many objects that arouse no feelings and excite no volition. Many objects loom up before the mind against our will.

The assumption that all psychic being is activity, is an unwarranted postulate. The question whether the soul is a substance or an activity, can be answered only by an examination of all the facts. If psychic activities are not self-explanatory, an ulterior subject of them must be admitted, even though the investigation could proceed no further than to show its existence. Now, psychic activities subsisting in themselves are inconceivable. Every activity proceeds from a subject, which initiates it, sustains it, and directs it. The theory of hypostatized psychic activity can be formulated in words, but the intellect is as incapable of thinking activity

as existing without an agent as of conceiving motion existing apart from a moving object.

The ego's experience of itself does not agree with Wundt's description of it as continuous, homogeneous, successive activity. The mental activity of the individual, through experience, education, and training, is the gradual perfection of a permanent personality; and psychic memory dispositions, enduring after the experience they record, are impossible in any but a permanent subject. The hypothesis that the knowledge acquired, the character developed, and the experience remembered, are transmitted in their constantly increasing total by every fundamental psychic act to its immediate successor, is unfounded in fact and unthinkable in logic. For, in the absence of a spiritual soul, psychic activity must be a material process of some kind; and, if this is admitted, the insurmountable difficulties bound up with psychological materialism will follow. The brain is the only permanent subject admitted by Wundt as the foundation of psychic life, but this basis is entirely inadequate to explain the spiritual development of the human intellect and will, which is essentially different from the progressive perfection of organic functions.

318. The Soul a Substance.—The concept of substance has changed so radically in the course of modern philosophy [1] that it needs careful definition when applied to the soul. Substance is here understood as a reality existing in itself, independently of second causes. Subsistence, or *inseitas*, is the primary characteristic of substance, differentiating it from accidents, which naturally inhere in a sub-

[1] See COFFEY, *Ontology* (1914), pp. 213–32.

stance. Substance does not exist in itself in the sense that it is uncaused, for every substance throughout nature has an efficient cause that brings it into existence. But, once it exists, a substance is independent of its cause for the continuation of its existence. Hence, it would be erroneous to consider substance as the "core" of reality on which the accidents are superimposed. The accidents inhere in their substance in the sense that it supports them in existence, and they on their part actualize its potentialities. Substance is not inert, for every being is a nature—that is, a principle of operation. The activities of the soul proceed from it as their ultimate principle. Every being may be considered, from the viewpoint of existence, as its static aspect, and, from that of action, as its dynamic aspect. Substance is not essentially active. It is essentially a principle of action, whether it actually exercises its active powers at a given moment, or whether they remain quiescent for the time being. Permanence is not an essential character of substance. Whether a substance exists only for an instant or for an epoch, it is a substance for the time of its actual duration. Accidents, such as quantity, may be as permanent as substances, but, since they inhere in the latter and cannot naturally exist in themselves, they retain their nature as accidents throughout the time of their existence. Substances may be destroyed like accidents. The essential characteristic by which a substance is constituted is its existence in itself, independently of other objects. A self-existent substance has its existence of itself, in virtue of its essence. God is the only self-existent substance. A contingent substance, such as the soul

and every natural object, has its existence from its efficient cause. The human soul is a substance in the sense that it is a real being that was caused in time, and is the ultimate principle of all psychic activity of the individual person, but does not inhere in another being.

319. The proof of the substantiality of the human soul proceeds from the fact that every person has his own consciousness and his own psychic activities. Everyone reacts to sense stimulus in his own individual way, and by acts that are distinct and separate from those of all other persons. His knowledge is all his own, he forms his own opinions, makes his own inferences, is guided by his own principles, and has his own character. Every person is, therefore, not only a physically distinct being, but he possesses his own individual psychic acts.

320. Since these acts proceed from a spiritual principle, the further question arises as to whether every person possesses an individual principle of psychic activity, or whether the psychic activities of all men proceed from one and the same spiritual principle that is operative in every person. Monopsychism is not an error that has been definitely buried in the distant past. Its refutation is not the slaying of the slain, but coping with an error embodied in modern pantheism.

The consciousness of every individual has an immediate perception of its own acts, and institutes comparisons between them without being obliged to recur to a medium in or through which they are brought together for comparison. But no one ever has an immediate perception of the psychic acts of

other persons, nor can an immediate comparison be instituted between them. Since the subject of psychic experience in any given individual is incapable of performing these acts which every other subject performs for himself, all psychic subjects are distinct from each other. The hypothesis that the immediate psychic perceptions and their comparison in different persons are in a single subject, which is unable to compare these different groups with one another, is unfounded, because, as the experience of the individual evidences, the presence of psychic acts in consciousness is the only condition required for their immediate perception and comparison. If the psychic acts of different persons were actually in a single universal consciousness, it would by this very fact have an immediate perception of all of them, and be able to institute an immediate comparison between them. As this is evidently impossible, the conclusion is inevitable that the psychic acts of every individual proceed from a distinct psychic principle.

Hence, the soul is a substance in the sense that it is the independent reality which is the cause and the subject of all psychic activity of the individual.

§ 2. SPIRITUALITY OF THE SOUL

321. The Soul a Spirit.—A spirit is a being that is intrinsically independent of matter in existence and activity. Spirituality is not a negative property, though it is often expressed in negative terms, such as immateriality and incorporeality. A spiritual being has its own life, which is governed by the principles of truth and morality, not by the mechanical

causality of the physical world. The soul is extrinsically dependent on the senses and the other parts of the nervous system, which supply the material of thought and volition, but even the sensory activities of man are not purely material. If the brain is injured, the soul cannot think, but brain and thought are not therefore identical, any more than a motor car is identical with gasoline because it cannot be operated if the supply of fuel is exhausted. The extrinsic dependence of the soul on the brain is that of a cause on a condition or a prerequisite. The soul would be intrinsically dependent on the brain, and consequently material, only if the brain were a partial eliciting cause of its thought and volition.

322. The distinction between soul and matter is established by a comparison of its activities and properties with those of matter. If, as will be shown, these properties are mutually exclusive in the same subject, the soul is distinct from the brain; and, if they are incompatible with the properties of matter, the soul is immaterial or spiritual, for the principle of a given activity, and the subject of a given property, must be proportionate to it.

All the activities of the soul that experience makes known to us must be included in this investigation. If the soul can be shown to possess only a single activity or property that is intrinsically independent of matter, its spirituality is established, even though it exercises other activities that are intrinsically dependent on the brain and the senses. The opposite inference, deducing the materiality of the soul from its need of a corporeal organ for certain activities, is no more valid than the conclusion that bone is

wood, because it has some of the properties of wood, or that wire is cotton thread, because both of these substances have length and strength. The nature of a being is always determined by the characteristics that are proper and essential to it.

323. Extension and local motion are the essential properties of matter. Sensory experience always manifests its object as occupying space in three dimensions and as changing its position in space. These properties are inherent in corporeal objects in themselves, independently of our perception of them, just as these objects exist in themselves, apart from the mind that perceives them. Hence, the spatial properties of material objects are not creations of the imagination, like those we attribute to fictitious products of our own fancy. Material objects, then, are extended realities capable of local motion.

The activities of the soul and their products in our consciousness are devoid of these essential properties of matter, and hence the nature of the soul is not that of matter. We form representations of motion in our imagination, or the concept of motion in the intellect, but these acts are not therefore processes of local motion. Feelings of pleasure and pain have neither length nor breadth. They arise in our consciousness, continue for a time, and finally cease; but these phases of duration, though they have a physiological foundation implying motion, do not consist in motion.

The objects of sensation are extended in space, but sensation itself has no extension. If color sensations were material like their objects, they would also have the chemical and physical properties and the same activities that colors possess in nature.

If perceptions were material processes, they would have the same spatial properties as their objects, and be identical in all beholders. But the illusions that occur very frequently in everyday life show that these perceptions do not represent their objects as they are outside the mind. Angular surfaces are perceived as flat or round, moving objects appear to be stationary, complementary and contrasting color sensations are formed, the relative size of objects is misjudged. Furthermore, the sensations produced in different persons by the same object under identical conditions are not the same. Now, if perceptions were material like the objects they represent, they would have the same properties as their objects, or they would at least undergo identical modifications in different subjects.

324. The activities of the soul are not aspects or functions of chemical or physiological processes taking place in the brain, because they are so disparate that they must be placed in an entirely different category of being. The fundamental property of every cerebral activity is extension and local motion. Now, the nature of joy and sorrow, of doubt and conviction, of desire and aversion, has no constituent element that can be classed as extension or motion in sound logic and on the basis of experience.

Consciousness and its acts are not epiphenomena of neural structure and activity. A by-product of neural activity can only be material, like its principle, and it must inhere in a material subject. Now, it was shown above that the content of consciousness is not material, and hence it is not identical with any epiphenomenon of the brain or the nervous system. If it is conceived as something distinct

from the brain, it must be identified and described, not in terms of inanimate matter, but as having the same nature as the content of consciousness.

325. The activities of the brain and the nerves are a partial cause of the sensory activities of the soul, but they have no intrinsic part in the rational activities of intellection and volition. The nature of sensation and of the other sensory activities of man proves that the soul is not material like the objects of sense perception, but it does not prove the spirituality of the soul, since all sensory activity is dependent on the brain and the sense organs. But the rational activities of the soul are intrinsically independent of matter, and afford a conclusive proof of the spirituality of the soul. The sensory faculties prepare the material for intellection and volition, by giving it a psychic form, but they have no part in the elicitation of these acts.

326. The intellect knows material objects in an immaterial manner, and therefore by immaterial acts. In forming concepts, the intellect abstracts from the individualizing marks of objects, not by diverting the attention from them, but by omitting them from the concept, and so making it independent of its realization in time and space. Now, an organic representation may omit certain individualizing marks, but whatever it retains of its object is concrete and individual. Hence, the concept, being independent of the essential characters of matter and organic representation, is the term of an immaterial act, and this in its turn proceeds from an immaterial or spiritual principle.

327. The intellect knows immaterial objects, which cannot be known by an organic faculty, be-

cause the latter can represent only those objects that have material properties. Concepts, such as science, unity, relation, or virtue, and principles, such as those of causality and of sufficient reason, have a sharply defined meaning in the intellect, but they are incapable of being realized as such in the material world. Truth, goodness, and beauty are intelligible to every mind, but they cannot be found *as such* outside of the intellect. Now, an organic faculty cannot represent objects that lie beyond the realm of the material world, because an activity cannot be more perfect than the principle that elicits it. Since the intellect knows objects that are independent of matter, it performs cognitional acts that are likewise independent of matter; and, because the activities of a faculty are proportionate to its nature, the intellect is independent of matter, or spiritual.

328. In the act of reflection, the intellect makes its own acts and its own self the object of its thought, turning back, so to say, upon itself in its totality. It observes the rise, the progress, and the passing of its acts. In this process the thinking subject is at the same time its own object of thought, and the perception of itself, as remaining identical with itself throughout life, is the sure guarantee of the identity and individuality of the human personality. Now, an organic faculty could at most turn back one of its parts upon another, but never the whole upon itself, since the impenetrability of matter prevents any such action. The eye cannot perceive itself nor its vision. Much less could an organic faculty reflect on its reflection, or upon the reflection on its first reflection, as the intellect is

easily capable of doing. Hence, the power of reflection is a spiritual act, and the intellect, as its eliciting cause, is a spiritual principle.

329. The power of reflection proves the simplicity of the soul, because a composite and therefore extended principle could at most turn back one part upon the other, but never the whole upon itself.

In the act of sensation, we perceive an object or a number of objects in a single, unitary perception. Now, a perception of this kind, having for its object an extended being, or a group of extended beings, cannot be the act of a faculty that is composed of parts, for either each part of this faculty would perceive only a part of the object, or each part would perceive the entire object. In the first case, we would have a group of partial perceptions of the object, each differing from the others, and, in the second, we would have as many total perceptions of the object as there are perceiving parts of the faculty. In neither case would there be a single, unitary perception of the object.

330. The will is an immaterial faculty, because its activity, like that of the intellect, is independent of matter and of the laws and conditions of matter. The will strives for immaterial objects (such as virtue and goodness, wisdom and knowledge), and it is governed by laws that have nothing in common with the laws of matter. The natural law and its ethical standards are in no way akin to the physical and chemical laws that govern the activities of matter. The will is free to act or not to act when all the conditions for its action are given, but material causes are necessitated to action by their nature. The will acts on rational motives, which are inde-

pendent of matter, but material agents strive blindly with no self-chosen purpose in view.

331. Intellect and will control many of the organic activities of man, and direct them, not according to material laws nor for the attainment of material ends, but for the acquisition of immaterial truth and goodness. Intellect and will are perfected throughout the course of human life, while the organic faculties undergo a gradual, but inevitable decline. Emotions and appetites of the sensory nature are controlled and repressed by the will, and the activities of the senses are not left to wander at random, but put into the service of the intellect. Errors of sense perception are detected and corrected, and ingenious methods and instruments are devised to increase the usefulness of sensation for the ends proposed by the mind and sought by the will. Man's rational nature derives the highest enjoyment from the pursuit of science and the cultivation of the arts amid the sore distress of his sensory nature through hardship and poverty. Emotions of shame and regret, of admiration and reverence, are unknown among animals, and are evidence of a higher principle—the spiritual soul—in man.

§ 3. UNITY OF THE SOUL

332. Unity of the Soul.—The rational, sensory, and vegetative activities of man all proceed from the rational soul, not from distinct vital principles. The unity of the soul is the only sufficient reason for the unity of human consciousness. Though the three classes of vital activities differ greatly from one another in character, it is always the rational

ego that is aware of sensation and sense appetition, and of all the functions and needs of the vegetative life, as belonging to it and exercised by it.

The interdependence of the vegetative, sensitive, and rational life also points to the unity of the soul. Without the vegetative functions, sensory and rational activities would be impossible in man. The vegetative activities build up the brain, the sense organs, and the entire human organism, and so construct the somatic basis required for sensation. Intellect and will derive the material for thought and volition from the acts of the sensory faculties. The sensory activities are in the service of the vegetative life, for the necessary food must be discovered through the sense organs and acquired through the organs of motion. The rational faculties, likewise, must be put into the service of the vegetative life, since the natural instincts of man are insufficient to protect his body from harm without the use of the intellect.

The activities of mind and sense exhaust and break down the nerve structures, and, unless they are quickly restored, sensory and rational activities cannot continue. Intellectual pursuits that completely engross the attention prevent the action of the senses and even the pangs of hunger from being noticed. Sense indulgence dulls the mind and weakens the will. On the other hand, intense activity of mind and sense exercise a marked influence on the vegetative functions. Violent emotions increase or retard the action of the heart, disturb the digestion, and alter respiration.

The conflict between the will and the sense appetite, each striving intensely for its own object and thereby impeding the attainment of the other, is experienced as the inclination of the one ego toward mutually exclusive objects. If the sensitive soul were distinct from the rational soul, each could pursue its object without evoking a distressing reaction in the subject, for there would then be two agents in the one subject, and the unity of the ego would no longer be maintained.

333. Unity of Man.—The soul and the body of man are united into one nature and one person. A nature is the ultimate principle from which an activity proceeds. The eye is not the ultimate principle of sight, for, if it is exsected or if it remains in the lifeless body, it is incapable of performing its function. It is the organ of vision only as a part of the living organism.

Two principles, such as soul and body, constitute one nature when they are so united that, in virtue of their union, the resultant substance is the principle of an activity that neither of them *per se* can separately perform. Two horses drawing a wagon, which neither of them can draw separately, are not a parallel to the union of two principles into one nature, because the effect resulting from their combined efforts merely exceeds in degree, but not in kind, the capacity of each of them. The activity of a new nature resulting from the union of two principles is of a higher kind—not degree—than the capacity of the constituents. Similarly, the combination of various parts into a microscope is not their union into one nature, because they do not form a

new intrinsic principle of operation, but their natural and antecedent capacities are merely combined and utilized by an extrinsic agent that directs, modifies, and coördinates them.

When soul and body are united to constitute the human substance, they are one principle, positing activities that each of them, taken separately, is essentially incapable of performing. Neither the soul alone, nor the body alone, has the capacity of performing any sensory or vegetative action. When the soul is separated from the body, it retains the sensory and vegetative faculties, but, lacking the requisite organs, it is incapable of performing their actions. The body without the soul is equally incapable of them. The vegetative activities of the organism are not limited to the production of the chemical compounds found in the body; they develop and preserve the organic structures, and, independently of the stimulus of environment, perform functions that transcend the activities of inanimate beings, such as the formation of cells and the coördination of all their activities for the welfare of the organism.

Having thus a single principle of operation, man is a person—that is, a complete and independent rational substance. All his activities ultimately proceed from this one substance, at times acting through the spiritual faculties alone and at times through the organic faculties. All the activities of man, rational, sensory, and vegetative, are therefore attributable to this one human substance, whether they are elicited by the soul alone or performed through an organic faculty.

§ 4. ORIGIN OF THE SOUL

334. The Soul is Created by God.—Since living beings originate only from living matter in nature, the question arises whether the human soul takes its origin in the same way from the soul or the body of the child's parents. The solution of this problem must be formulated with due regard for matter and its possibilities, and for the soul as a spirit.

The soul of the child cannot take its origin from the body of the parents, because matter cannot produce spirit, which by its nature and activities belongs to a higher order than any material substance. A cause cannot act beyond its own capacity, so as to produce an effect that is essentially in a higher order of being. Any material cause that may come into question for the origin of the soul is merely organic matter, and it could therefore at most produce a material effect, such as the body in its most rudimentary state, but not the spiritual soul.

Neither can the soul of the child originate from the souls of the parents, because, being spiritual, they are indivisible, so that the soul of the child cannot be a segment of the parental soul.

It is equally impossible that the soul should come into being through any disposition of matter brought about by the parents, because a material substance has none but material powers, and no causal action that is not material in its nature; it can produce only matter, but never a spirit. Nor can matter by any mysterious force be transmuted into spirit, so that a principle of organic life would in due time be changed into a spiritual soul.

Creation, which is proper to God alone, is the

only mode of origin through which the human soul can come into existence. Creation, the production of a thing out of nothing, excludes the preëxistence of both the object created and of any substratum from which it might be educed. It was shown above that the soul cannot be educed from matter or from spirit, and, on the other hand, the soul does not preëxist before it informs the body, for it is by its nature intended to exist in the body and to form one substance with it. The separation of the soul from the body is violent and unnatural, because, being deprived of the use of its sensory faculties, from which intellect and will derive the material from which thought and volition (the distinctive activities of man) are elaborated, the soul cannot lead its complete, normal life apart from the body. Hence, there is no rational motive on the ground of which God would create the soul before there is an incipient body to receive it, and to be developed by its activity.

No creature has the power of creation. The action of all the causes in nature is limited to the change of preëxistent matter by the eduction of new forms through the actualization of its potentialities. The production of a being as such, in the form of matter or of spirit, is the prerogative that distinguishes the causality of the First Cause from that of second causes.

§ 5. IMMORTALITY

335. The Soul is Immortal.—Immortality is perpetual life. The immortality of the soul is its existence forever, and its perpetual exercise of vital ac-

tivity. Mere survival is not immortality, because it does not include vital activity. Three distinct propositions are implied in the immortality of the soul: its survival after death, the continuance of its vital operations in this state, and the perpetual duration of both.

336. The question of the immortality of the soul is far from being a purely speculative problem. For, if the soul is immortal, the practical attitude of man toward the present life is necessarily conditioned by its bearing on his life after death. The ideals based on the assumption of a purely mortal existence, which ceases completely in death, must yield place to speculative and ethical principles that take into consideration the whole of human existence. What may be most desirable for a purely mortal life in the way of intellectual pursuits, ethical standards, artistic ideals, and physical well-being, requires a complete revaluation *sub specie æternitatis*. Ideals that must be judged impractical, visionary, and reactionary from the viewpoint of purely mundane progress, virtue, and happiness, are amply justified and recognized in the unique position of being alone true and useful if the soul lives on forever after death. Hence, the solution of the question of immortality must be studied with an open mind, free from mundane weakness, predilections, and prejudices. Only then, in the cold, clear light of reason, can the truth be found.

337. The human soul is naturally incorruptible or imperishable. A being is corruptible, either because it has in itself a cause or a condition that may bring on its destruction, or because it depends for its existence on another being that is perishable. In the

first instance, it is corruptible by its nature; in the second, by reason of its dependence. A chemical mixture is by its nature perishable by reason of its composition, because its elements remain separable, and, the more complex its molecular composition, the more labile or perishable it is. A tree is perishable for the further reason that it depends on outward causes for its existence. If the soil in which it is rooted, or the air it breathes, were destroyed, it would perish, since they are essential to its life and growth.

338. The human soul is by its nature incorruptible or imperishable, because it contains no principle or condition in itself that can bring about its destruction, and does not depend for the continuance of its existence on any creature extrinsic to itself. An intrinsic condition leading to its destruction would necessarily consist in the soul's composition of other substances or substantial principles, or in its natural extension in space, by reason of which it could be divided into parts and so destroyed. Now, the soul is a simple being, and therefore devoid both of integral and constituent parts. Hence, it is by its nature immune from destruction that is brought about by the separation of a being into its parts or by its resolution into its component elements.

339. The soul is immune from the second manner of destruction, in which a being perishes through the destruction of another object on which its existence essentially depends. For intellection and volition, its chief activities, are carried on without intrinsic dependence on other beings. It is true that the soul derives, from sensory cognition, the material from which it elaborates concepts, but the acts

of the intellect are elicited by the spiritual faculty alone, without the coöperation of the brain and the senses. The principle from which these acts proceed is proportionate to them. Since they are independent of matter, this principle is likewise independent of matter and of material conditions in its existence. Hence, the soul is not dependent on the body for its existence, and cannot perish through the destruction of the body, or by separation from it. Even if the soul never possessed the actual use of reason and will when it was united with the body, because the brain and the senses were not sufficiently developed to supply these faculties with the material for the abstraction of ideas and for volition, its intellect and will are spiritual, and consequently independent of extrinsic beings in their existence and their capacity for action.

340. The soul is capable of vital activity after it is separated from the body. Not only do intellect and will remain intact, but the memory retains and actuates the knowledge acquired during its mortal life. The soul retains the power of reflecting on itself, and is furthermore capable of knowing itself directly. By means of these acts, it forms its first ideas, if it has not exercised the power of thought when united with the body, and enlarges the field of its knowledge, if it possessed the use of reason during its earthly existence. In a similar manner, it acquires a knowledge of other souls, and especially of God, the Author of its being.[2]

341. The soul lives forever. Since the rational activities of the soul are given with its nature, it

[2] St. Thomas, *Summa Theologica* I, Q. lxxxix, and cross-references there.

will suffice to prove its perpetual existence in order to show that it possesses unending life. Two causes, —namely, a creature capable of destroying the soul, and God, its Creator—come into question as extrinsic agents possessing the power of terminating the soul's existence by annihilation.

The soul cannot be annihilated by any creature, because the activity of all natural agents is directed toward the production of a positive effect, consisting either in substantial or accidental change. Nothing is annihilated in nature. Whether a pure spirit has the power of annihilating, need not be investigated here. It suffices for the present question to recall that all spirits are subject to God, and that they cannot act counter to His designs regarding the soul of man.

God wills the perpetual life of the soul, for it is His creature, and He cannot have endowed it with a naturally imperishable nature, unless He desires this noblest of its capacities to serve its only natural purpose—namely, the perpetual continuance of its highest vital activities. Any other course would be incompatible with the Divine Wisdom, for it would mean the construction of an everlasting habitation for the dweller of a day.

Intellect and will cannot be taken from the soul, for they are one with its substance; thus, the perpetual vital activity of the soul is given with its nature. No creature can impede the exercise of these faculties, or remove their objects from their ken. The soul is the object of its own knowledge, and cannot be separated from itself. The other intelligible objects that the soul discovers by reflection are likewise immanent in its substance, or, if

they are made known to the soul by God, His unfailing Providence will not destroy the work of His hands.

Collateral Reading.—Mercier, *Manual of Modern Scholastic Philosophy,* Vol. I, pp. 298–328; Maher, *Psychology,* Chapters XXI–XXVI; Gruender, *Psychology without a Soul;* Pyne, *The Mind,* pp. 103–62.

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Chapter X

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GLOSSARY

Achromatic. 1. Resisting the usual staining agents. Said of the more fluid parts of the cell and the linin. 2. Colorless. Applied to the black-and-white series of visual sensations. (Gr. *a,* without; *chrōma,* color.)

Amitosis. Direct cell division, without the formation of the nuclear figures. (Gr. *a,* without; *mitos,* thread.)

Amphiaster. The stage of indirect cell division in which the staining filaments of the nuclear meshwork form two star-shaped figures connected by the spindle. (Gr. *amphi,* around; *astēr,* star.)

Anabolism. The building up of food into living tissue. (Gr. *ana,* up; *ballō,* throw.)

Aqueous Humor. The fluid that fills the anterior chamber of the eye, from the cornea to the lens.

Association Fiber. A nerve fiber that connects the cells of the same hemisphere of the brain.

Association Path. A connection between association fibers that is formed or developed through the exercise of their functions.

Aster. The star-shaped structure surrounding the centrosome. (Gr. *astēr,* star.)

Attraction Sphere. A minute particle in the cell body near the nucleus of many cells, forming the central mass of the aster and often possessing radiating fibers.

Auricle. The external ear. (L. *auricula*, diminutive from *auris*, ear.)

Axon. An outgrowth of a nerve cell, consisting of the essential nerve substance. The axon transmits the excitation of the nerve. (Gr. *axōn*, axle.)

Basilar Membrane. The spiral membrane supporting the organ of Corti in the cochlea. (Gr. *basis*, stepping, base.)

Catabolism. The breaking down of living matter within the cell. (Gr. *kata*, down; *ballō*, throw.)

Cell Membrane. The cell wall or sheathlike covering of a cell. It is not necessarily a separate part, but may be the outer layer of the cell substance.

Centrosome. An extremely small and deeply staining particle, or usually a pair of such particles, that lie in the body of the cell near the nucleus and form the center of the attraction sphere in the process of indirect cell division. (Gr. *kentron*, center; *sōma*, body.)

Cerebellum. The little brain, below and behind the cerebrum. (L. dim. of *cerebrum*.)

Cerebral Localization. The determination of the function-centers in the brain.

Cerebrum. The upper and forward part of the brain, consisting of two hemispherical masses. (L. = brain.)

Cholesterin. A crystalline compound. (Gr. *cholē*, bile; *stereos*, solid.)

Chromatin. The deeply staining substance of the nuclear net-work. (Gr. *chrōma*, color.)

Chromosomes. The deeply staining segments into which the nuclear net-work splits during indirect cell division. (Gr. *chrōma*, color; *sōma*, body.)

Ciliary. The ciliary process is the series of folds of the choroid coat of the eye arranged in a circle around the iris. (L. *cilium,* eyelash.)

Cochlea. The spiral passage of the internal ear. (L. *cochlea,* snail.)

Colloid. A glutinous substance that does not readily penetrate vegetable and animal membranes. Opposed to crystalloid. (Gr. *kollōdēs,* gluey.)

Commissural Fiber. One of the nerve fibers that join the hemispheres of the brain.

Commissure. One of the bridge-like structures that unite the two hemispheres of the brain. (L. *commissura;* from *cum,* with, *mitto,* send.)

Conduction. The transference of the influence of a stimulus along the nerve-fibers from the point of stimulation to the nerve-center.

Corpora Quadrigemina. Four round projections situated behind the third ventricle of the brain, and containing gray matter. (L. = fourfold bodies.)

Corpus Striatum. A group of ganglionic cells at the base of the hemispheres of the brain. (L. = furrowed body.)

Cortex. The outer layer of the brain. (L. = bark.)

Crystalloid. One of a class of substances that are readily diffused. (Gr. *krustallos,* crystal.)

Dendron. One of the short processes issuing from many nerve-cells, and branching like roots or branches of a tree. (Gr. *dendron,* tree.)

Dispirem. The stage of indirect cell division in which each daughter-nucleus has formed its nuclear skein, or spirem. (Gr. *dis,* twice; *speirēma,* skein.)

Electrolysis. The decomposition of a chemical compound by passing an electric current through it. (Gr. *elektron,* amber; *luo,* dissolve.)

Electrolyte. A chemical compound that may be decomposed by passing an electric current through it. (Gr. *elektron,* amber; *luo,* dissolve.)

Endolymph. The fluid that fills the membranous labyrinth of the ear. (Gr. *endon,* within; L. *lympha,* water.)

Entelechy. In the Aristotelian philosophy, completed realization, as distinguished from *dynamis* (potentiality) and *energeia.* (Gr. *en,* in; *telos,* end, completion; *echō,* have.)

Ependyma. The tissue lining the central cavities of the brain and the spinal cord. (Gr. *epi,* upon; *enduma,* garment.)

Epiphenomenon. A by-product; a secondary phenomenon. (Gr. *epi,* upon; *phainomenon,* participle from *phainō,* appear.)

Eustachian Tube. The passage by which the middle ear communicates with the pharynx. Named for Bartolomeo Eustachio, an Italian anatomist (1500–1574).

Excitation. The arousement of a nerve by the application of a stimulus.

Facilitation. The intensification of a reflex by a different stimulation of the same group of cells.

Fiber. A fine filament of nerve, muscle, or connective tissue. *See* **Association Fiber, Commissural Fiber, Projection Fiber.**

Fibril. A minute fiber.

Ganglion. An enlargement on a nerve, consisting of a group of nerve-cells, from which nerve fibers radiate. (Gr. *ganglion,* tumor.)

Ganglion Cell. A large cell with a well-marked nucleus, characteristic of the gray matter of the central nervous system.

Granular. Composed of, or containing small grains. (L. *granum,* grain.)

Hyaloid. The hyaloid membrane is the transparent membrane enclosing the vitreous humor of the eye. (Gr. *hualos,* glass; *eidos,* form.)

Indirect Cell Division. The division of cells, through which new cells originate, by the formation of the nuclear figures.

Inhibition. The weakening or the suppression of a reflex, caused by the simultaneous presence of another sense-stimulus besides that causing the reflex.

Innervate. To impart or direct nervous energy from a central organ to any part of the nervous system.

Karyokinesis. Indirect cell division. See this term. (Gr. *karuon,* nut; *kinēsis,* change, movement.)

Karyomitome. The nuclear net- or mesh-work. (Gr. *karuon,* nut; *mitos,* thread.)

Karyoplasm. The more fluid part of the nucleus of a cell. (Gr. *karuon,* nut; *plasma,* a thing moulded or formed.)

Karyotheca. The special membrane surrounding the nucleus. (Gr. *karuon,* nut; *thēkē,* case.)

Labyrinth. The winding passages of the inner ear. The bony labyrinth is hollowed out in the temporal bone and contains the membranous labyrinth. (Gr. *laburinthos,* labyrinth.)

Lecithin. A phosphorized fat contained in the cell material. (Gr. *lekithos,* yolk of an egg.)

Linin. The fibers of the nuclear mesh-work that have little affinity for dyes. (L. *linum,* linen thread.)

Localization. The reference of sensation to a particular part of the body, or to a place outside the body. *See* **Cerebral Localization.**

Mastoid Antrum. A cavity in the temporal bone, communicating with the tympanum in front, and with the mastoid air cells below and behind. (Gr. *mastos,* breast; *eidos,* form; L. *antrum,* cave, cavity.)

Measure of Receptivity. The maximum stimulus that is still able to increase the intensity of sensation.

Medulla Oblongata. The ganglion that connects the brain with the spinal cord. (L. = long marrow.)

Medullary Sheath. A fat-like sheath surrounding the central substance of certain nerve fibers. (L. *medulla,* marrow.)

Metabolism. The process by which food is built up into living matter, or by which the latter is broken down within the cell. The former process is called *anabolism,* the latter *catabolism.* (Gr. *meta,* signifying change; *ballō,* throw.)

Metaplasm. The lifeless matter included in a cell, such as reserve and waste products. (Gr. *meta,* beyond; *plasma,* a thing formed or moulded.)

Mitome. The mesh-work that permeates the more fluid part of the cell body. (Gr. *mitos,* thread.)

Mitosis. Indirect cell division by the formation of the nuclear figures. (Gr. *mitos,* thread.)

Myelin Sheath. Medullary sheath. See this term. (Gr. *muelos,* marrow.)

Nasopharynx. The upper part of the canal that leads from the base of the skull to the esophagus. (L. *nasus,* nose; Gr. *pharynx,* throat.)

Neuroblast. An embryonic cell that develops into a nerve cell. (Gr. *neuron,* nerve; *blastanō,* sprout, grow.)

Neuro-fibril. A minute nerve fiber. (Gr. *neuron,* nerve; *fibra,* fiber.)

Neuroglia. The supporting tissue of the central nervous system. (Gr. *neuron,* nerve; *gloia,* glue.)

Neuron. A nerve cell with all its processes, the axon and dendrons. (Gr. = nerve.)

Nissl Body. The Nissl bodies are small irregular masses found in the protoplasm of the cell body. They consist of nucleo-proteid containing organically combined iron, and stain easily. When the cell is fatigued, they break up and gradually disappear. Named for their discoverer, Franz Nissl (1860–1919), a German neurologist.

Nuclear Figures. The progressive series of changes which the nucleus undergoes in the process of indirect cell division.

Nucleic Acid. A non-crystalline acid that is present in the nucleus, and may be broken up into a nuclein base and phosphoric acid.

Nuclein. A compound of nucleic acid and albumin, forming the chemical basis of chromatin. (L. *nucleus,* kernel.)

Nucleolus. An intensely staining body in the meshwork of some nuclei. (L. dim. of *nucleus,* kernel.)

Nucleo-protein. A nuclein or paranuclein compound with a special albuminous radical. (L. *nucleus,* kernel; Gr. *prōtos,* first.)

Nucleus. The round or oval body embedded in the protoplasm of the cell. It is the principal organ by means of which the vital functions of the cell are carried on. (L. = kernel.)

Optic Thalami. Two bodies of gray matter beside the third ventricle of the brain and connected with the origin of the optic nerve. (L. *thalamos,* chamber.)

Organ of Corti. The end-organ of the auditory nerve in the cochlea. Named for its discoverer, Bonaventura Corti (1720–1813), an Italian anatomist.

Ossicle. A small bone. The auditory ossicles are three small bones, familiarly termed the hammer, anvil, and stirrup, within the tympanum. (L. *ossiculum,* dim. of *os,* bone.)

Paramitome. The more fluid part of the cell body. (Gr. *para,* beside; *mitos,* thread.)

Perilymph. The fluid that surrounds the membranous labyrinth of the internal ear. (Gr. *peri,* around; L. *lympha,* water.)

Phenomenon. Any fact or occurrence, especially in consciousness. (Gr. *phainomenon,* present participle, from *phainō,* appear.)

Photochemical. Pertaining to, or produced by the chemical action of light. In Hering's theory of vision, one of the three substances in the retina, which are subject to chemical action by light. (Gr. *phōs,* light; *cheō,* pour, mix.)

Plexus. An interlacement of nerves. (L. *plecto,* interweave.)

Pole. The place where the process of a cell issues from it. (Gr. *polos,* axis.)

Process. 1. A psychic activity. 2. A fiber issuing from a nerve cell. *See* **Axon** and **Dendron.**

Projection Fiber. One of the nerve fibers that connect the brain cells with the subcortical nerve centers. *See* **Subcortical Nerve Center.**

Protein. An albuminous compound derived from a proteid. (Gr. *prōtos,* first.)

Protoplasm. The living matter of a cell, as distinguished from the metaplasm. Often used to designate the substance of the cell body, as distinguished from that of the nucleus. (Gr. *prōtos,* first; *plasma,* a thing formed or moulded.)

Psychophysical. In the philosophy of Wundt, pertaining to the empirically determined relations between the physical and the psychical aspects of the vital process. *See* **Psychophysical Parallelism.**

Psychophysical Parallelism. The theory that psychical and physical phenomena are parallel manifestations of one and the same underlying reality.

Reaction. Psychic response to stimulation. The *reaction period* is the time required for a response to a stimulus of sensation.

Reflex. The involuntary transformation of a centripetal into a centrifugal nerve impulse by means of a central organ.

Scala. Any of the passages of the cochlea of the inner ear. The *scala tympani* is the upper winding chamber of the cochlea, communicating with the middle ear through the round window. The *scala vestibuli* is the lower chamber of the cochlea, communicating with the vestibule. (L. *scala,* ladder.)

Somatic Cells. Body cells, as distinguished from germ cells. (Gr. *sōma,* body.)

Spindle. The spindle-shaped arrangement of the

non-staining fibers in a stage of indirect cell division.

Spirem. The stage of indirect cell division in which the chromatin of the nucleus takes the form of a thread. (Gr. *speirēma,* coil, skein.)

Spontaneous Generation. The alleged origin of living matter from lifeless matter. Disproved by the experiments of Pasteur.

Stimulation. The application of an excitant to a nerve.

Stimulus. Any form of excitement that causes psychic activity, especially sensation. Stimuli are general or special, internal or external.

Stimulus Scope. The range of a stimulus between the stimulus threshold and the measure of receptivity.

Stimulus Threshold. The least amount of stimulus that can be perceived.

Subcortical Nerve Centers. The spinal cord, the corpora quadrigemina, and the optic thalami.

Subjective. Existing and valid only in consciousness, without a corresponding object in the external world.

Summation. The summation of stimuli is the production of a conscious effect through the aggregate influence of several stimuli, none of which singly is capable of producing it.

Taste Bud. The organ of taste, consisting of bud-shaped structures located chiefly in the circumvallate and fungiform papillæ of the tongue.

Teleological. Designed for an end or purpose. (Gr. *telos,* end.)

Thalamus. *See* **Optic Thalami.**

Threshold of Consciousness. The point where a stimulus begins to be perceived.

Threshold of Discrimination. The point where the difference between two stimuli begins to be perceived.

Tympanum. The middle ear, a bony cavity between the tympanic membrane and the cochlea, connecting with the Eustachian tube. The tympanum contains the auditory ossicles. (Gr. *tumpanon,* drum.) *See* **Ossicle.**

Vermiform Process. Either surface of the median lobe of the cerebellum. (L. *vermiformis,* worm-shaped.)

Vitreous Humor. The transparent, jelly-like tissue that fills the eyeball. (L. *vitreus,* from *vitrum,* glass.)

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